11-6625-673-15-1

TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT,

AND GENERAL SUPPORT MAINTENANCE MANUAL

TEST SET,
INDICATOR-GENERATOR,
TACHOMETER TTU-27/E
CONTRACT NUMBER F41608-67-C-7762

(NSN 6625-00-621-2427)

This copy is a reprint which includes current pages from Changes 1 and 2. Title was changed by Changes 1 and 2.

HEADQUARTERS, DEPARTMENT OF THE ARMY

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WARNING

Dangerous voltages exist in this equipment. During testing operations, 115 volts ac is present. Serious injury or death may result from contact with internal connections at switches and transformers.

Technical Manual
No. 11-6625-673-15-1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, *22 June 1970*

Operator's, Organizational, Direct Support, General Support, and Depot Maintenance Manual
TEST SET, INDICATOR-GENERATOR, TACHOMETER TTU-27/E
CONTRACT NUMBER F41608-67-C-7762

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Figure 1-1. Test Set, Indicator-Generator, Tachometer TTU-27/E.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual describes Test Set, Indicator-Generator, Tachometer TTU-27/E (fig. 1-1), Federal Stock No. 6625-621-2427, procured on contract No. F41608-67-C-7762, and provides instruction for operation, maintenance, functioning of equipment, and depot overhaul. Appendixes include references, the maintenance allocation chart, and the illustrated parts list.

NOTE

Appendix C is current as of 1 May 1970.

1-2. Indexes of Publications

a. DA Pam 310-4. Refer to DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

1-3. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Maintenance forms, records, and reports which are to be used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

b. Report of Packaging and Handling Deficiencies. Fill out and forward DD Form 6 (Report of Packaging and Handling Deficiencies) as prescribed in AR 700-58 (Army)/NAVSUP PUB 378 (Navy)/AFR 71-4 (Air Force)/and MCO P4030.29 (Marine Corps).

c. Discrepancy in Shipment Report (DISREP) (SF 361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38 (Army)/NAVSUP PUB 459 (Navy)/AFM 75-34 (Air Force)/and MCO P4610.19 (Marine Corps).

1-3.1. Reporting of Equipment Publication Improvements

The reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forwarded direct to Commander, US Army Electronics Command, ATTN: AMSEL-MA-A, Fort Monmouth, NJ 07703.

Section II. DESCRIPTION AND DATA

1-4. Use of Term Hertz

The National Bureau of Standards has officially adopted the term Hertz (Hz) to replace cycles per second (cps). The chart below provides common equivalents of the unit/quantity terms and the list of approved abbreviations used in the manual.

Unit/quantity	*Old term*	*Old abbreviation*	*New term*	*New abbreviation*
Frequency	Cycles per second	cps	Hertz	Hz
10^3 cycles per second	Kilocycles per second	Kc	Kilohertz	kHz
10^6 cycles per second	Megacycles per second	Mc	Megahertz	MHz
10^9 cycles per second	Gigacycles per second	Gc	Gigahertz	GHz

1-5. Purpose and Use

Test Set, Indicator-Generator, Tachometer TTU-27/E (hereinafter referred to as tachometer tester) is a portable field instrument for checking the performance characteristics of aircraft tachometer indicators and generators. Representative types of equipment which will be checked by the test set are covered by MIL-G-5413, four-pole generators; MIL-G-9398, two-pole generators; MIL-I-7098, rpm type indicators; and MIL-I-7069, percent rpm indicators. The tachometer tester allows generator evaluation of output voltage under load when mechanically driven by the aircraft. Tachometer indicators are tested for calibration accuracy and starting voltage while excited by the tachometer tester's master generator or by an aircraft driven generator.

1-6. Description

a. General. The tachometer tester consists of a panel subassembly mounted in a carrying case assembly with five adapter cables, two tee adapter cables, and a powerline cable.

b. Carrying Case Assembly. The carrying case houses a panel subassembly, provides storage space for the cables and displays a chart of operating instructions on the inside of the lid. The carrying case, including projections of latches, feet and handle, is 20½ inches long, 10 inches wide, and 11¾ inches deep. The carrying case contains a hinged lid supported by two folding stays to hold the lid in the open position when the tachometer tester is being used. The cover protects the unit when the tachometer tester is not in use.

c. Panel Subassembly. The panel subassembly mounts all components and assemblies of the tachometer tester. The tachometer tester therefore remains functional after removal of the panel subassembly from the case. This allows case of servicing without the need of any special extender cables. The panel subassembly consists of all operating controls, switches and indicators mounted on the panel, a chassis assembly, a digital speed indicator assembly and a variable drive unit. The chassis assembly mounts the circuit electronic components, power supplies, pulse rate to dc voltage converter, rpm indicator servo amplifier, dc motor controller, and test generator load resistors.

d. Accessory Cables. The accessory cable particulars are tabulated in table 1-1. The cables allow connections to be made between the tachometer tester and indicators when powered by the tachometer tester or by an aircraft driven generator. The cables also allow tachometer generators to be connected to the tachometer tester when mechanically rotated by the tachometer tester variable speed drive or while functioning in an aircraft.

Table 1-1. Accessory Cables (fig. 1-1)

Cable	*Part No.*	*Function*
Powerline connector cable Length—10 feet.	B667-372	Connects tachometer tester to 115-volt, single-phase, 400-Hz power source.
Adapter cable length—10 inches	B667-370	Connects 3-pin tachometer generator or indicator to tachometer tester.
Adapter cable length—36 inches	B667-371	Same as adapter cable B667-370.
Adapter cable length—36 inches	B667-367	Connects 5-pin tachometer generator or indicator to tachometer tester.
Adapter cable length—10 inches	B667-368	Connects 2-pin tachometer generator or indicator to tachometer tester.
Tee adapter cable	B667-374	Provides tee tap into aircraft mounted and operating 3-pin tachometer generator and indicator system. Tee tap allows tachometer tester to be connected in parallel with indicator.
Tee adapter cable	B667-375	Provides tee tap into aircraft mounted and operating 5-pin tachometer generator and indicator system. Tee tap allows tachometer tester to be connected in parallel with indicator.
Adapter cable length—20 feet	B667-369	Connects either Tee adapter cable B667-374 or B667-375 to tachometer tester.

1-7. Item Comprising an Operable Equipment

Test Set, Indicator-Generator, Tachometer TTU-27/E comprises an operable equipment and is shown in figure 1-1.

CHAPTER 2

CIRCUIT FUNCTIONING

2-1. Principles of Operation

The tachometer tester is employed to perform tests on tachometer indicators and generators while they are installed in an aircraft or at the bench. The calibration accuracy of tachometer indicators can be determined as well as their required starting voltage. Tachometer generators can be tested under selectable resistive loads for output voltage. A block diagram of the tachometer tester is shown in figure 2-1; figure 2-2 is the schematic diagram.

2-2. Indicator Calibration Accuracy

Indicator calibration accuracy is determined by energizing the indicator under test from the tachometer tester master tach G1. The master tach output is applied through GEN OUTPUT jack J2 to the indicator under test when OUTPUT switch S2 is in the MASTER GEN position. The three-phase voltage applied to J2 is controlled by MASTER GEN OUTPUT potentiometer R43. The voltage applied to the indicator under test is monitored by the GEN OUTPUT VOLTAGE meter M1 when the LOAD switch S4 is in the OFF position. The master tach is rotated by dc drive motor B1. Dc drive motor B1 is a separately excited shunt wound motor. The field is energized by 115 volts dc as developed by a bridge rectifier consisting of diodes CR9 through CR12. Power to energize the armature is taken directly from the 115-volt line and rectified through SCR1. The speed of motor B1 varies in proportion to the level of dc voltage applied to its armature. The INCREASE SPEED control R42 in the low level control circuit of SCR1 varies the period of conduction of SCR1 during each cycle of line voltage. Varying the conduction period in turn varies the dc voltage applied to the armature of B1 and hence its speed. The motor speed is stabilized by the velocity feedback signal of dc tach generator G2. The MASTER INDICATOR displays the precise speed of the drive motor when INDICATOR switch S6 is in the MASTER GEN position. In the MASTER GEN position, the voltage across phase A-C of the master tach G1 activates the MASTER INDICATOR control circuits. The output of the master tach G1 is a signal whose frequency is proportional to its rotational speed. This signal is amplified through V1 and V2 to a level sufficient to operate polarized relay K1 through a complete cycle of its operation for each cycle of the master tach output. Relay K1 allows charging and discharging of the precision capacitor of network R2 and C1. Equal energy pulses are generated for each cycle of signal generated by the master tach. These pulses are integrated in the resistor-capacitor network consisting of R3, C2, R4, C3, R5 to perform a digital to analog conversion of these pulses to an average dc potential proportional to the output frequency of the rotating tach generator. This dc voltage is applied to one side of chopper K2. A dc voltage representing the position of feedback potentiometer R29 is applied to the other side of the chopper. Chopper action compares these two dc voltages and generates an ac signal whose peak-to-peak amplitude is equal to the difference or error between the two dc voltages. The electrical frequency of this ac error signal is equal to the mechanical frequency of chopping performed by K2 or 400 Hz. The ac error signal is amplified in preamplifier V3 and push-pull driver V4. V4 drives the output servomagnetic amplifier AR1. The output of amplifier AR1 energizes the control phase of the two-phase servomotor B2. The five digit MASTER INDICATOR and the feedback potentiometer R29 are positioned by servomotor B2. When the error signal generated by chopper K2 is zero the MASTER INDICATOR will have been positioned to indicate the speed of rotation corresponding to or proportional to the dc voltage generated by the pulse rate to dc converter. The proportionality of the rpm indication to this dc voltage is determined by the RANGE switch S5. The MASTER INDICATOR reading may be selected as RPM X 1, RPM X 2 or RPM PERCENT. Upon selection of the proper range, the MASTER INDICATOR accurately displays the rpm or the percent rpm as should be indicated on the indicator under test.

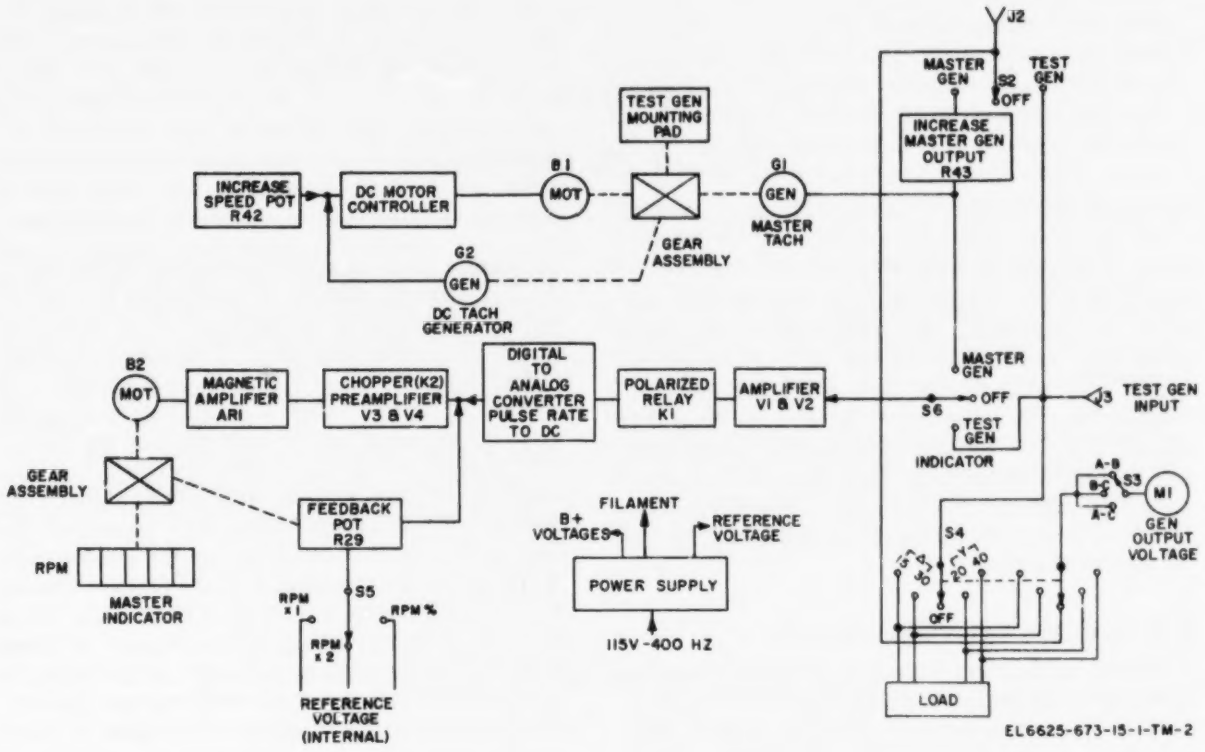

Figure 2-1. Test Set, Indicator-Generator, Tachometer TTU-27/E, block diagram.

Amplifier plate voltage is developed by the full-wave bridge rectifier CR5 through CR8 and regulated by voltage regulator V7. The reference voltage for the servo feedback potentiometer R29 and the network R2 and C1 source potential is also derived from the bridge rectifier CR5 through CR8 but regulated by V5 and V9 in series.

2-3. Indicator Starting Voltage

Indicator starting voltage tests are performed utilizing the master tachometer generator as in the calibration test. The voltage applied to the indicator under test is varied through MASTER GEN OUTPUT control R43. The voltage is monitored by GEN OUTPUT VOLTAGE meter M1 when LOAD switch S4 is in the OFF position. The master tach generator speed at which the monitored voltage is being developed is displayed on the MASTER INDICATOR. Therefore, at a given generator speed the voltage applied to the indicator under test may be increased by R43 until the indicator starts. This starting voltage is accurately displayed on meter M1.

2-4. Generator Resistive Load–Output Voltage Test

Generator tests may be performed by mounting a generator on the test pad. Drive motor B1 rotates the generator under test through the test pad at a speed controlled by the INCREASE SPEED control R42. The speed of rotation of the test generator is displayed on the MASTER INDICATOR. The three-phase output of the generator under test is applied to the tachometer tester through TEST GEN INPUT jack J3. J3, through LOAD switch S4, applies the generator output to the selected three-phase wye or delta connected load. The voltage developed across each leg of the three-phase load is monitored on GEN OUTPUT VOLTAGE meter M1. The phase voltage being monitored by M1 is selected by TERM CONN switch S3.

2-5. Testing Aircraft Installed Generators and Indicators

System testing while mounted in the aircraft and driven by the aircraft engine may also be accom-

plished with the tachometer tester. The dc drive system of the tachometer tester is not employed during such a test since the aircraft engine is rotating the tachometer generator. By employing one of the tee adapter cable assemblies between the generator and indicator, an input to the test set at TEST GEN INPUT jack J3, may be made. From jack J3, a signal is applied to the MASTER INDICATOR circuitry when the INDICATOR selector switch S6 is in the TEST GEN position. Aircraft engine speed is thus read on the MASTER INDICATOR. Generator loads may be applied to the test generator through LOAD switch S4 and generator phase voltage may be read on GEN OUTPUT VOLTAGE meter M1 as selected by TERM CONN switch S3.

Figure 2-2. Test Set, Indicator-Generator, Tachometer TTU-27/E, schematic diagram.

(Located in back of manual)

CHAPTER 3

OPERATION

3-1. Operating Controls and Indicators

Before operating the tachometer tester, become thoroughly familiar with the controls and indicators as illustrated in figure 3-1. The functions of all controls and indicators are tabulated in table 3-1.

Table 3-1. Operating Switches, Controls, Indicators, and Jacks

Switch, control, indicator, or jack	Index No. fig. 3-1	Switch position	Function
POWER switch (2-position toggle)	1	Off (down)	Removes power to tachometer tester.
		ON	Applies 115-volt, 400-Hz, single-phase power at POWER INPUT jack to internal circuitry.
INCREASE SPEED control	2		Controls speed of the motor driving the master generator and the test pad drive shaft.
MASTER INDICATOR	3		Indicates rpm of test pad drive shaft speed.
RANGE switch (3-position rotary)	4	RPM X-1	Causes MASTER INDICATOR to display rpm of indicator under test.
		RPM X-2	Causes MASTER INDICATOR to display two times rpm of indicator under test.
		RPM PERCENT	Causes MASTER INDICATOR to display percent rpm of indicator under test.
INDICATOR switch (3-position toggle).	5	OFF	Removes power from MASTER INDICATOR.
		MASTER GEN	Routes output from internal master generator to MASTER INDICATOR.
		TEST GEN	Routes output from TEST GEN INPUT jack to MASTER INDICATOR.
LOAD switch (5-position rotary)	6	15△	Connects 15-ohm delta load across TEST GEN INPUT jack.
		30△	Connects 30-ohm delta load across TEST GEN INPUT jack.
		OFF	Connects GEN OUTPUT VOLTAGE meter to GEN OUTPUT jack.
		20Y	Connects 20-ohm wye load across TEST GEN INPUT jack.
		40Y	Connects 40-ohm wye load across TEST GEN INPUT jack.
GEN OUTPUT VOLTAGE meter	7		Indicates voltage across phases selected by TERM CONN switch.
TERM CONN switch (3-position rotary).	8	A-B	Connects GEN OUTPUT VOLTAGE meter across phase A and B of load selected by LOAD switch.
		B-C	Connects GEN OUTPUT VOLTAGE meter across phase B and C of load selected by LOAD switch.
		A-C	Connects GEN OUTPUT VOLTAGE meter across phase A and C of load selected by LOAD switch.
OUTPUT switch (3-position toggle)	9	MASTER GEN	Applies internal master generator output to GEN OUTPUT jack.
		OFF	Disconnect signal to GEN OUTPUT jack.
		TEST GEN	Connects TEST GEN INPUT jack to GEN OUTPUT jack.
MASTER GEN OUTPUT control	10		Adjusts level of three-phase voltage output of internal master generator.
GEN OUTPUT jack	11		Connection point for supplying output of internal master generator or test generator (as selected by OUTPUT switch) to external equipment.

Table 3-1. Operating Switches, Controls, Indicators, and Jacks—Continued

Switch, control, indicator, or jack	Index No. fig. 3-1	Switch position	Function
TEST GEN INPUT jack	12		Connects output from test generator to tachometer tester.
Test pad	13		Mount for generator under test.
POWER INPUT jack	14		Connection point for tachometer tester external power source.
Power indicator	15		Lights when power is applied to tachometer tester and POWER switch is in ON position.

3-2. Preoperation Requirements

The following must be available for performing tests:

a. Tachometer tester including powerline connector cable and adapter cables.

b. Power source of 115 volts, 400 Hz, single phase (capable of furnishing 250 volt-amperes (va)) available within 10 feet of tachometer tester location.

c. Aircraft tachometer indicator and/or generator for test.

3-3. Equipment Turn On

CAUTION

Before setting POWER switch to ON, make ground connection at source end of power cable and set INCREASE SPEED control fully counterclockwise (ccw).

a. To turn equipment on, set the operating controls as follows:

(1) INCREASE SPEED control ..... Fully ccw
(2) RANGE switch ..... RPM X 1

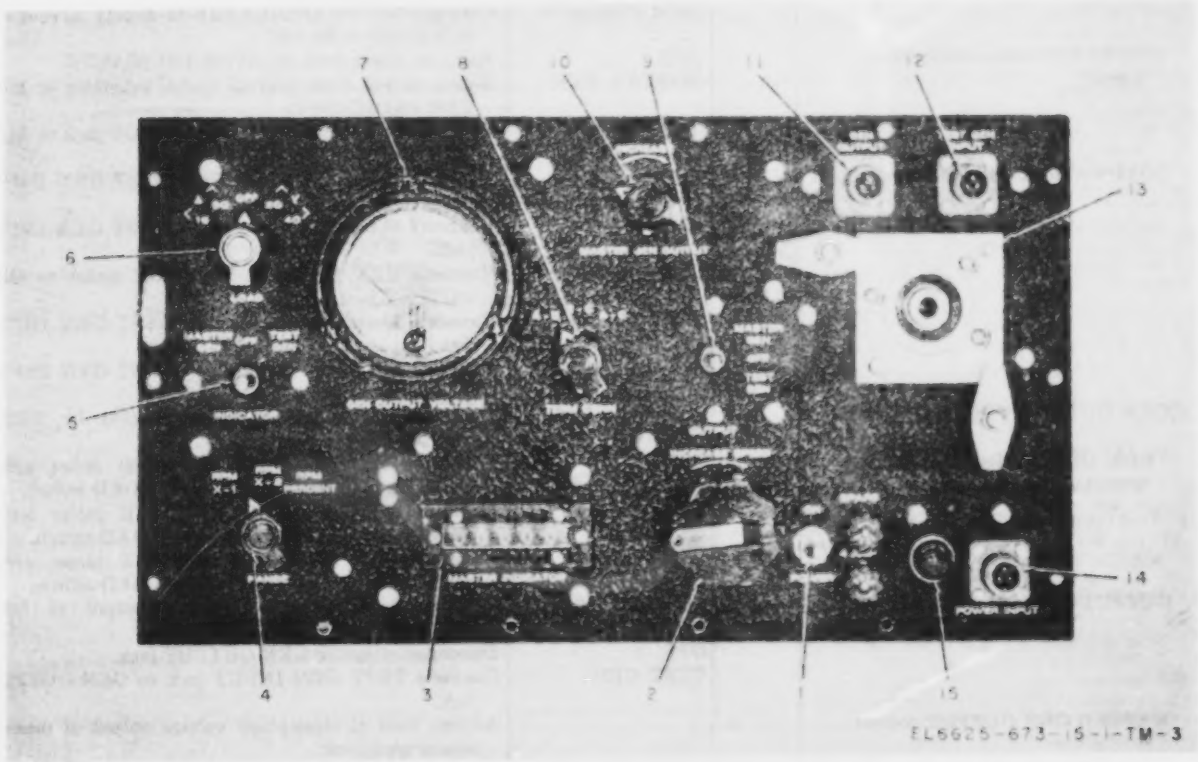

Figure 3-1. Front panel, controls, and indicators.

(3) INDICATOR switch ... OFF
(4) LOAD switch ... OFF
(5) TERM CONN switch ... Any position
(6) OUTPUT switch ... OFF
(7) MASTER GEN OUTPUT control ... Fully ccw

b. Set POWER switch to ON.

c. Set INDICATOR switch to MASTER GEN.

d. Allow equipment to warm up for 5 minutes.

3–4. Indicator Tests

a. Speed Calibration.

(1) Set controls as indicated in paragraph 3–3.

(2) Set OUTPUT switch to MASTER GEN.

(3) Connect indicator to be tested to the GEN OUTPUT jack with the appropriate adapter cable.

NOTE

With LOAD switch in OFF position, GEN OUTPUT VOLTAGE meter reads voltage at GEN OUTPUT jack.

(4) Rotate INCREASE SPEED control until MASTER INDICATOR reads 4200 ±10 rpm.

(5) Increase MASTER GEN OUTPUT control until a reading of 21 volts is indicated on GEN OUTPUT VOLTAGE meter.

(6) Check indicator calibration at speeds specified in the maintenance instructions for the indicator under test.

b. Starting Voltage.

(1) Set controls as in paragraph 3–3.

(2) Set OUTPUT switch to MASTER GEN.

(3) Connect indicator to be tested to the GEN OUTPUT jack with the appropriate adapter cable.

NOTE

The tachometer tester may be used as either a fixed frequency-variable voltage source or a fixed voltage per unit frequency-variable frequency source. The applicable test shall be performed as specified in the maintenance instructions for the indicator to be tested.

(4) To use as a fixed frequency source—

(*a*) Rotate INCREASE SPEED control until MASTER INDICATOR indicates frequency (rpm) specified in the maintenance instructions for the indicator under test.

(*b*) Rotate MASTER GEN OUTPT control until indicator under test just starts to run at synchronous speed.

(*c*) Read voltage on GEN OUTPUT VOLTAGE meter.

(*d*) This voltage shall not exceed that specified in the maintenance instructions for the indicator under test.

(5) To use as a variable frequency source—

(*a*) Rotate INCREASE SPEED control until MASTER INDICATOR indicates 2,000 ±10 rpm.

(*b*) Rotate MASTER GEN OUTPUT until GEN OUTPUT VOLTAGE meter reads 2000 times voltage factor specified in the maintenance instructions for the indicator under test.

(*c*) The tachometer tester is now calibrated as a fixed voltage per unit frequency source.

(*d*) Rotate INCREASE SPEED control for a zero reading on MASTER INDICATOR.

(*e*) Set INCREASE SPEED control as specified in the maintenance instructions for the indicator under test.

3–5. Generator Test

a. Set controls as in paragraph 3–3.

b. Install generator to be tested on test pad and clamp in place.

c. Connect appropriate cable between generator and TEST GEN INPUT jack.

d. Set LOAD switch to value specified in the maintenance instructions for the generator under test.

e. Rotate INCREASE SPEED control until MASTER INDICATOR reads speed specified in the maintenance instructions for the generator under test.

f. Read generator phase voltage as selected by TERM CONN switch and indicated on GEN OUTPUT VOLTAGE meter.

3–6. Engine Driven Generator-Indicator Speed Calibration

a. Set controls as in paragraph 3–3.

b. Connect appropriate tee adapter in aircraft harness at tachometer indicator or generator. Using additional appropriate cables, complete connections placing TEST GEN INPUT jack in parallel with the aircraft indicator.

c. Set POWER switch to ON.

d. Set INDICATOR switch to TEST GEN.

e. Allow a 5 minute warmup.

f. Aircraft engine speed is accurately measured by MASTER INDICATOR.

3–7. Deenergizing Tachometer Tester

a. Rotate INCREASE SPEED control full counterclockwise.

b. Set INDICATOR switch to OFF.

c. Set POWER switch to OFF.

CHAPTER 4

OPERATOR AND ORGANIZATIONAL MAINTENANCE

Section I. PERIODIC INSPECTION, MAINTENANCE, AND LUBRICATION

4-1. Scope of Maintenance

The maintenance duties assigned to the operator and organizational repairmen are listed below together with a reference to the paragraphs covering the specific maintenance functions.

a. Daily preventive maintenance checks and services (para 4-4).

b. Weekly preventive maintenance checks and services (para 4-5).

c. Quarterly preventive maintenance checks and services (para 4-6).

d. Cleaning (para 4-7).

e. Touchup painting (para 4-8).

4-2. Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. Systematic Care. The procedures given in paragraphs 4-4 through 4-7 cover routine systematic care and cleaning essential to proper upkeep and operation of the equipment.

b. Preventive Maintenance Checks and Services. The preventive maintenance checks and services charts (paras 4-4, 4-5, and 4-6) outline the functions to be performed at specific intervals. These checks and services are to maintain Army electronic equipment in a combat serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist operators in maintaining combat serviceability, the charts indicate what to check, how to check, and the normal conditions; the *Reference* column lists the illustrations, paragraphs, or manuals that contain detailed repair or replacement procedures. If the defect cannot be remedied by performing the corrective actions listed, higher level maintenance or repair is required. Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38-750.

4-3. Preventive Maintenance Checks and Services Periods

Preventive maintenance checks and services for the equipment are required daily, weekly, and quarterly.

a. Paragraph 4-4 specifies the checks and services that must be accomplished daily (or at least once each week if the equipment is maintained in a standby condition).

b. Paragraphs 4-5 and 4-6 specify additional checks and services that must be performed on a weekly and quarterly basis, respectively.

4-4. Daily Preventive Maintenance Checks and Services Chart

Sequence No.	Items to be inspected	Procedure	Reference
1	Completeness	Check for completeness of the equipment	Fig. 1-1
2	Exterior surfaces	a. Clean the exterior surfaces including the front panel of the tachometer tester and the storage compartment.	a. Para 4-7
		b. Make visual inspection for dents and cracks	b. None
3	Cable assemblies	Check the cable assemblies to ensure that they are free from dirt and moisture.	Para 4-7, fig. 1-1
4	Switches, controls and indicators	While making operational checks (5 below), observe that the mechanical action of each knob and switch is smooth and free from internal and external binding, and that there is no excessive looseness. Check meter for sticking or bent pointer.	None
5	Operation	During normal operation of the equipment, check meter for proper zero adjustment.	Para 4-10

4-5. Weekly Preventive Maintenance Checks and Services Chart

Sequence No.	Items to be inspected	Procedure	Reference
1	Exterior surfaces	Inspect exposed metal surfaces for rust and corrosion. Touchup paint as required.	Para 4-8
2	Cable assemblies	Inspect cables and test leads for cracked, chafed, or frayed insulation. Inspect connectors for damage or defects; replace as necessary.	Fig. 1-1

4-6. Quarterly Preventive Maintenance Checks and Services Chart

Sequence No.	Items to be inspected	Procedure	Reference
1	Publications	See that all publications are complete, servicable and current.	DA Pam 310-4
2	Operation	Every other quarter (semiannual) schedule the tachometer tester for internal inspection, lubrication, and calibration.	Para 4-9 and ch. 6
3	Master tachometer generator	Every other quarter (semiannual) perform operational check.	Ch. 3
4	MASTER INDICATOR	Every other quarter (semiannual) perform operational check.	Ch. 3
5	Modifications	Check DA Pam 310-7 to determine existence of applicable MWO's. Check the equipment to determine if MWO's have been performed. All URGENT MWO's must be applied immediately. All NORMAL MWO's must be scheduled.	DA Pam 310-7

4-7. Cleaning

Inspect the exterior of the equipment. The exterior surfaces should be free of dust, dirt, grease, and fungus. Remove dust and loose dirt with a clean, soft cloth.

WARNING

The fumes of trichloroethane are toxic. Provide thorough ventilation whenever used. DO NOT use near an open flame. Trichloroethane is not flammable, but exposure of the fumes to an open flame converts the fumes to highly toxic, dangerous gases.

a. Remove grease, fungus, and ground-in dirt from the equipment using a cloth dampened (not wet) with trichloroethane.

CAUTION

Do not press on the meter face (glass) when cleaning; the meter may be damaged.

b. Clean the front panel, meters, control knobs, and switches; use a clean soft cloth. If necessary, dampen the cloth with water; mild soap may be used for more effective cleaning.

4-8. Touchup Painting

Remove rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to the applicable cleaning and refinishing practices specified in TB 746-10.

4-9. Lubrication

The only component of the tachometer tester that requires lubrication is the test pad portion of the drive assembly. Apply a 1/64-inch film of heavy silicone grease, Dow Corning Type DC 33 (FSN 9150-754-0351), or equivalent, to both sides of both gears in the drive assembly at each 6-month inspection period. The grease should cover the complete area from the hub to the outside diameter of the gears.

4-10. OUTPUT VOLTAGE Meter Adjustment

Prior to zero adjustment of the tachometer tester OUTPUT VOLTAGE meter, set the POWER switch to the off (down) position. Using a small screwdriver, turn the meter zero adjustment screw so that the meter indicates zero.

Section II. PREPARATION FOR LIMITED STORAGE AND SHIPMENT

4-11. Inspection Prior to Storage

Prior to placement in storage for a short term upon removal from service, a thorough visual inspection should be performed. It should be noted and so indicated by appropriate tagging of the unit as a result of such inspection, deficiencies such as broken or missing parts or accessories.

4-12. Accessory Cable Storage

The powerline connector cable and the adapter cables should be placed in the accessory storage compartment of the carrying case prior to unit storage.

4-13. Storage Precautions

The lid of the carrying case should be secured in the closed position by its latches, prior to storing the tachometer tester.

4-14. Packaging

For shipment the tachometer tester should be packaged in accordance with the following:

a. Prepare the test set in its carrying case in accordance with paragraphs 4-11 and 4-12.

b. Place desiccant units, Specification MIL-D-3464, in carrying case. Secure the lid in the closed position with its latches.

c. Place tachometer tester in an inner carton conforming to Federal Specification PPP-B-636 and seal with tape, Federal Specification UU-T-111, class 2.

d. Attach humidity indicator to carton.

e. Insert carton containing tachometer tester in a barrier bag conforming to Specification MIL-B-131, class 1.

f. Place barrier bag with corner cushions, Federal Specification PPP-C-00850, in outer carton, Federal Specification PPP-B-636. Eight corner cushions are used per carton.

g. Tape the outer carton with tape conforming to Federal Specification PPP-T-45A, type 2.

h. Mark for shipment as required per MIL-STD-129.

Section III. DEMOLITION TO PREVENT ENEMY USE

4-15. Authority for Demolition

Demolition of the equipment will be accomplished only upon order of the commander. Use the destruction procedures outlined in paragraph 4-16 to prevent further use of the equipment.

4-16. Methods of Destruction

NOTE

Use any of the following methods to destroy the equipment. If time permits, remove panel assembly for carrying case.

a. Smash. Use sledges, axes, hammers, crowbars, and any other heavy tools available to smash interior units of the set

(1) Use the heaviest tool available to smash the connectors and knobs and the voltmeter.

(2) Use a heavy hammer or crowbar to smash printed circuit boards, switches, relays and resistors.

(3) Use the heaviest tool available to smash the drive assemblies.

b. Cut. Use axes, handaxes, machetes and similar tools to cut cabling and accessory cables in a number of places.

c. Burn. Burn the technical manuals first. Burn as much of the equipment as is flammable.

d. Dispose. Bury or scatter destroyed parts or throw them into nearby waterways. This is particularly important if a number of parts have not been completely destroyed.

CHAPTER 5

DIRECT SUPPORT MAINTENANCE

5-1. General

Troubleshooting is performed whenever it is established that the tachometer tester is not functioning properly, either because one of its testing functions is inoperative or because the MASTER INDICATOR cannot be calibrated. In general, the malfunction can be localized to a specific circuit from the nature of the trouble. *For example*, a malfunction that is evidenced during indicator tests may be due to either a defective master tachometer generator or to a defective output voltage adjusting circuit. The trouble can be localized quickly by noting the MASTER INDICATOR reading. Normal MASTER INDICATOR readings indicate a properly functioning master generator. When analyzing troubles, frequent reference should be made to the functional block diagram and principles of operation of the tachometer tester in chapter 2. Reference should be made to the overall schematic diagram in figure 2-2 when alayzing circuit malfunctions.

5-2. Troubleshooting Procedures

Table 5-1 describes the symptoms of defective operation that may be encountered during service, along with the probable causes of the symptoms and remedial action to be taken. In the event that the precision speed indicator circuits malfunction, isolate the trouble to a specific printed circuit board. Then, utilize standard troubleshooting procedures to correct the malfunction. Resistance and voltage data for the printed circuit boards are tabulated in tables 5-2 and 5-3 respectively.

Table 5-1. Troubleshooting

Symptom	Probable cause	Corrective action
1 Neither drive motor B1 nor the MASTER INDICATOR functions with POWER switch ON.	a. Defective 115 V, 400 Hz receptacle J1.	a. Check and replace J1.
	b. Defective POWER switch S1	b. Check and replace S1.
	c. Defective fuse F1	c. Check and replace F1.
2 MASTER INDICATOR functions normally; drive motor B1 not turning.	a. No voltage on field winding	a. Check for voltage across field terminals at motor assembly. Check and replace defective rectifiers CR9, CR10, CR11, CR12, or capacitor C20.
	b. Defective armature diode CR14	b. Check CR14 for short and replace if required.
	c. Defective silicon controlled rectifier SCR1.	c. Check SCR1 and replace if required.
	d. Improper voltage to SCR1 gate terminal.	d. Perform voltage and resistance measurements of SCR1 gate circuit.
3 MASTER INDICATOR functions normally; drive motor speed cannot be adjusted.	Improper voltage to SCR1 gate terminal.	Perform voltage and resistance measurements of SCR1 gate circuit.
4 Drive motor functions normally, MASTER INDICATOR does not respond to changes in speed.	a. Precision speed indicator circuits defective.	a. Isolate the trouble to a specific portion of chassis. Perform voltage and resistance measurements.
	b. Servomotor B2 defective	b. Check B2 and replace if required.
5 Drive motor functions normally, MASTER INDICATOR does not respond to change in speed with OUTPUT switch at MASTER GEN position.	a. Defective master tachometer generator G1 or associated connector P1.	a. Check master generator in accordance with paragraph 3-5; replace if defective.
	b. Defective INDICATOR switch S6.	b. Check S6 and replace if required.

Table 5-1. Troubleshooting—Continued

Symptom	Probable cause	Corrective action
6 Output voltage of tachometer generators under test cannot be monitored; speed indications normal.	a. Defective GEN OUTPUT VOLTAGE meter M1.	a. Check and replace M1 if required.
	b. Defective TERM CONN switch S3.	b. Check and replace S3 if required.
7 Output voltage of master tachometer generator cannot be adjusted; speed is indicated on MASTER INDICATOR.	a. Defective MASTER GEN OUTPUT control R43.	a. Check and replace R43 if required.
	b. Defective TERM CONN switch S3.	b. Check and replace S3 if required.
	c. Defective GEN OUTPUT VOLTAGE meter M1.	c. Check and replace M1 if required.
8 MASTER INDICATOR cannot be calibrated when RANGE switch S5 is at RPMX1.	Defective resistor R23, or indicator calibrate potentiometer R26.	Check and replace defective resistor or potentiometer.
9 MASTER INDICATOR cannot be calibrated when RANGE switch S5 is at RPM X 2.	Defective resistor R24, or indicator calibrate potentiometer R27.	Check and replace defective resistor or potentiometer.
10 MASTER INDICATOR cannot be calibrated when RANGE switch S5 is at RPM PERCENT.	Defective resistor R25, or indicator calibrate potentiometer R28.	Check and replace defective resistor or potentiometer.
11 MASTER INDICATOR runs to one extreme and stays there.	a. Pulse rate or error detection circuits defective.	a. Troubleshoot circuits as required. Check power supplies associated with these circuits.
	b. Open feedback potentiometer R29.	b. Check continuity.
12 MASTER INDICATOR hunts	Defective servoamplifier circuit V4 and AR1.	Check tube and troubleshoot appropriate circuit.
13 Tube filaments do not light	Defective transformer T1 in power supply, or defective wiring.	Check T1 and wiring; replace if required.
14 MASTER INDICATOR does not function normally; counter drives below the zero position.	Pin attaching gear assembly to variable resistor R29 has sheared.	Remove digital speed indicator assembly and replace pin.

Table 5-2. Resistance Data

Terminal	Board 1	Board 2	Board 3	Board 4	Board 5	Board 6
1	*240K-280K **405K-465K ***465K-525K	600 # #	#	3.3K	39K	1.1 Meg
2	0	0 # #	#	0	0	0
3	Inf	240 # #	925	0	39K	*240K-280K **405K-465K ***465K-525K
4	0	600 # #	*208K-248K **380K-445K ***445K-505K	20K # #		1.1K
5	3.3K	600 # #	0	0 # #		1.1K
6	50		*240K-280K **405K-465K ***465K-525K	270	510K	0
7	3.3K		#	#	55	3.4K
8	Inf		#	#		
9	Inf					
10	*10K					
11	**10K					

Table 5-2. Resistance Data—Continued

Terminal	Board 1	Board 2	Board 3	Board 4	Board 5	Board 6
12	***10K					
13	*208K-248K **380K-445K ***445K-505K					
14	*248K-288K **420K-485K ***485K-545K					

NOTES

INDICATOR, OUTPUT and LOAD switches in OFF positions, INCREASE SPEED control fully ccw.
Unless otherwise noted, all measurements are with respect to chassis ground, with negative polarity ohmmeter lead connected to ground.
*RANGE switch to RPM X 1 position.
**RANGE switch to RPM X 2 position.
***RANGE switch to RPM PERCENT position.
Do not measure.
Respect to pin 5, board 4 (with neg. ohmmeter lead on pin 5).

Table 5-3. Voltage Data

Terminal	Board 1	Board 2	Board 3	Board 4	Board 5	Board 6
1	93 V	• •	85 VAC	−2.2 V	0	0
2	0	• •	85 VAC	6.3 VAC	0	0
3	0	• •	108 V	0	0	93 V
4	6.3 VAC	2.7 VAC #	185 V	190 V # #	• •	108 V
5	115 VAC *	2.7 VAC #	0	• •	• •	108 V
6	115 VAC *		93 V	−7.4 V # #		6.3 VAC
7	115 VAC *		220 VAC	275 VAC		−2.2 V
8	24 VAC		220 VAC	275 VAC		
9	24 VAC					
10	• •					
11	• •					
12	• •					
13	185 V					
14	185 V					

NOTES

* INDICATOR switch set to MASTER GEN or TEST GEN.
• • Do not measure.
Taken with respect to pin 1, board 2.
Taken with respect to pin 5, board 4.
Reading should be taken between indicated terminals.
All voltage readings taken with a 20,000 ohm/volt voltmeter.
All readings are dc unless otherwise stated.
All readings are with respect to chassis ground unless noted otherwise.

5-3. Removal and Replacement

As noted in chapter 1, the tachometer tester is made up of a carrying case assembly and a panel subassembly. Disassemble the tachometer tester only to the extent necessary to make a required repair. Removal of the panel subassembly from the carrying case assembly (as shown in figure D-2) will permit most checks and repairs to be made. In some instances, however, a circuit board assembly will have to be repaired. In this event, it may be necessary to remove the printed circuit board assembly from the panel subassembly. Follow the procedures below for complete disassembly and reassembly of the test set. The index number and the figure number in appendix D is given in parentheses after each item.

5-4. Removal of Panel Assembly from Case Assembly

a. Remove shoulder screw and lock nut (7 and 8, fig. D-1) from lid stay assembly (3, fig. D-1) and base (31, fig. D-2).

b. Remove the fourteen screws and lockwashers (1, fig. D-1 attaching parts) from outer perimeter of the panel (43, fig. D-2).

c. Lift the panel assembly (1, fig. D-1) from of the panel (43, fig. D-2).

5-5. Removal of Chassis Assembly From Panel

a. Removal of Receptacle Connector (14, fig. D-2).

(1) Unsolder wires from connector pins and tag.

(2) Remove the four machine screws, lockwashers, and hexagon nuts.

(3) Lift receptacle connector from panel.

b. Removal of Indicator Light (fig. D-2).

(1) Unsolder the wires from the indicator light (21) terminals and tag.

(2) Remove the hexagon nut and lockwasher from the base of the indicator light.

(3) Lift the indicator light (21) from the panel (43) and replace the hexagon nut to indicator light base.

c. Removal of Fuse Holder (fig. D-2).

(1) Remove the cartridge fuse (19) from the fuse holder (20).

(2) Unsolder the wires from the fuse holder and tag.

(3) Remove the hexagon nut and lockwasher from the base of the fuse holder.

(4) Lift the fuse holder from the panel (43).

(5) Replace the fuse holder end cap.

(6) Replace the lockwasher and hexagon nut to the base of the fuse holder.

d. Removal of POWER Toggle Switch (18, fig. D-2).

(1) Remove the lugs from the switch terminals and tag wires.

(2) Remove the hexagon nut and washer from the switch mount shaft.

(3) Remove switch from rear of panel and replace the hexagon nut and washer to the switch shaft.

e. Removal of Variable Resistor (2, fig. D-2).

(1) Unsolder the wires from the resistor terminals and tag.

(2) Loosen the setscrew in knob (1, fig. D-1, attaching parts).

(3) Slide the knob from the shaft.

(4) Remove the two hexagon nuts from the resistor mount shaft.

(5) Remove variable resistor from rear of panel (43, fig. D-2).

f. Removal of Digital Speed Indicator Assembly (35, fig. D-2).

(1) Unsolder wires from variable resistor (2, fig. D-2) and tag.

(2) Unsolder wires from magnetic amplifier (2, fig. D-3) and tag.

(3) Remove four machine screws (36, fig. D-2) and four lockwashers (37, fig. D-2).

(4) Remove digital speed indicator assembly (35) from rear of panel (43).

g. Removal of Window Frame (28, fig. D-2).

(1) Remove the six machine screws and lockwashers from the window frame.

(2) Lift the frame from the panel (43, fig. D-2).

(3) Lift the window (29, fig. D-2) from gasket (30, fig. D-2).

(4) Lift the gasket from the panel.

h. Removal of RANGE Rotary Switch (4, fig. D-2).

(1) Unsolder wires from the switch terminals and tag.

(2) Loosen the setscrew in the knob (3, fig. D-2).

(3) Slide the knob from the switch shaft.

(4) Remove the hexagon nut and washer from the switch mount shaft.

(5) Remove the switch from the rear of the panel.

i. Removal of Pivot, Decimal Arm, Spring, and Lug.

(1) Remove the hexagon nut, machine screw, and lockwasher from the lug (27, fig. D-2).

(2) Remove the retainer ring from the pivot (24, fig. D–2).

(3) Slide decimal arm (25, fig. D–2) off the pivot.

(4) Remove the spring (26, fig. D–2) from the lug and the decimal arm.

(5) Remove the machine screw and lockwasher from the pivot.

(6) Remove the pivot from the panel.

j. Removal of Variable Resistor (10, fig. D–2).

(1) Unsolder the wires from the variable resistor terminals and tag.

(2) Remove the two screws, lockwashers, and spacer (11, fig. D–2) from the chassis assembly (fig. D–3).

(3) Loosen the setscrew in the knob (9, fig. D–2).

(4) Slide knob from resistor shaft.

(5) Remove the two hexagon nuts and lockwasher from the variable resistor mount shaft.

(6) Remove the variable resistor from the rear of the panel.

k. Removal of Printed Circuit Board Assembly (fig. D–4).

(1) Remove the two machine screws (18, fig. D–3), two lockwashers (19), and two locknuts (20).

(2) Remove the four machine screws (21) and four lockwashers (22).

(3) Unsolder the wires from the printed circuit board assembly and tag.

(4) Remove the two machine screws (41, fig. D–2) and lockwashers (42).

(5) Lift the printed circuit board assembly from the chassis assembly.

(6) Remove the bracket assembly (23, fig. D–3) by removing the two machine screws, two lockwashers, and two hexagon nuts.

(7) Lift the bracket assembly from the printed circuit board assembly (fig. D–4).

l. Removal of LOAD Rotary Switch (8, fig. D–2).

(1) Unsolder the wires from the switch terminals and tag.

(2) Loosen the setscrew in the knob (7, fig. D–2).

(3) Remove the hexagon nut and washer from the switch mount shaft.

(4) Remove the LOAD rotary switch from rear of the panel and replace the nut and washer on the mount shaft.

m. Removal of INDICATOR Toggle Switch (13, fig. D–2).

(1) Remove the lugs from switch terminals and tag wires.

(2) Remove the two machine screws and lockwashers from the switch mount.

(3) Remove the INDICATOR toggle switch from rear of the panel.

n. Removal of Voltmeter (15, fig. D–2).

(1) Remove the lugs from the meter terminals and tag the wires.

(2) Remove the three machine screws, lockwashers, and hexagon nuts from the meter mount ring.

(3) Lift the voltmeter from the panel.

o. Removal of TERM CONN Rotary Switch (6, fig. D–2).

(1) Unsolder the wires from the switch terminals and tag.

(2) Loosen the setscrew in the knob (5, fig. D–2).

(3) Slide the knob off the switch shaft.

(4) Remove the hexagon nut and washer from the switch mount shaft.

(5) Remove the TERM CONN rotary switch from the rear of the panel.

p. Removal of OUTPUT Toggle Switch (12, fig. D–2).

(1) Remove the lugs from the switch terminals and tag wires.

(2) Remove the two machine screws and lockwashers from the switch mount.

(3) Remove the OUTPUT toggle switch from the rear of the panel.

q. Removal of Test Pad Base (16, fig. D–2).

(1) Remove the three machine screws and lockwashers from the base.

(2) Remove the base from the panel.

r. Removal of Variable Drive Assembly (32, fig. D–2).

(1) Unsolder the wires from four terminals (36, fig. D–11) and tag.

(2) Disconnect the connector (4, fig. D–11) from the tachometer generator (5, fig. D–11).

(3) Remove the six machine screws (33, fig. D–2) and lockwashers (34).

(4) Remove the variable drive assembly from the rear of the panel.

s. Removal of Holdown (22, fig. D–2).

(1) Remove the stop nut from the pivot pin on the rear of the panel.

(2) Lift the holdown from the panel and replace the stop nut on the pivot pin.

t. Final Removal. Remove the six machine screws (39, fig. D–2) and lockwashers (40) from the panel and remove chassis assembly (38, fig. D–2) from panel assembly.

5-6. Disassembly of Chassis Assembly

a. Removal of Magnetic Amplifier (2, fig. D-3).

(1) Remove the four hexagon nuts and lockwashers from the mounting studs.

(2) Remove the magnetic amplifier from the mount bracket.

(3) Replace the hexagon nuts and lockwashers on the mounting studs.

b. Removal of Rectifier (27, fig. D-3).

(1) Unsolder the wires from the rectifier terminals and tag wires.

(2) Remove the hexagon nut from the rectifier base.

(3) Remove the lug (28, fig. D-3) from the rectifier base and tag wire.

(4) Remove the rectifier from the chassis assembly and replace the hexagon nut on the rectifier base.

c. Removal of Relay (14, fig. D-3).

(1) Remove the two machine screws and lockwashers which attach the support (12, fig. D-3).

(2) Lift the support from the standoff (13, fig. D-3). Remove the machine screw and lockwasher which attach the standoff.

(3) Remove the standoff from the chassis assembly.

(4) Pull the relay from the electron tube socket (15, fig. D-3).

d. Removal of Electron Tube Socket (15, fig. D-3).

(1) Unsolder the wires from the socket terminals and tag.

(2) Remove the two machine screws, hexagon nuts, and lockwashers.

(3) Lift the electron tube socket from the chassis assembly.

e. Removal of Transformer (1, fig. D-3).

(1) Unsolder the wires from the transformer terminals and tag.

(2) Remove the four hexagon nuts from the base of the transformer.

(3) Slide the transformer forward until the mount bolts clear the mount bracket.

(4) Lift the transformer from the chassis assembly.

f. Removal of Chopper (8, fig. D-3).

(1) Unfasten the clamp (9, fig. D-3) from around the chopper by exerting a small outward pressure at the fastener opening.

(2) Pull the chopper from the electron tube socket (16, fig. D-3).

g. Removal of Electron Tube Socket (16, fig. D-3).

(1) Remove the machine screw, lockwasher, and hexagon nut which attach the cable clamp (29, fig. D-3).

(2) Remove the cable clamp.

(3) Unsolder the wires from the electron tube socket and tag.

(4) Remove the two machine screws, hexagon nuts, and lockwashers from socket.

(5) Lift the electron tube socket from the chassis assembly.

h. Removal of Capacitor (10, fig. D-3).

(1) Unsolder the wires from the capacitor terminals and tag.

(2) Remove one machine screw, hexagon nut, and lockwasher and unfasten clamp (11, fig. D-3) from around capacitor.

(3) Remove the remaining two machine screws and hexagon nuts and slide the clamp over the capacitor away from the chassis.

(4) Remove the two machine screws, hexagon nuts, and lockwashers from the capacitor mounting base.

(5) Lift the capacitor from the chassis assembly.

i. Removal of Choke (7, fig. D-3).

(1) Unsolder the wires from the choke terminals and tag.

(2) Remove the four hexagon nuts and lockwashers from the mount bolts

(3) Lift the choke from the chassis assembly.

j. Removal of Fixed 15-Ohm Resistors (3, fig. D-3).

(1) Unsolder the wires from the three 15-ohm resistors and tag.

(2) Remove the two machine screws, lockwashers, and hexagon nuts that attach each resistor.

(3) Lift the resistors from the chassis assembly.

k. Removal of Fixed 20-Ohm Resistors (4, fig. D-3).

(1) Unsolder the wires from the three 20-ohm resistors and tag.

(2) Remove the two machine screws, lockwashers, and hexagon nuts that attach each resistor.

(3) Lift the resistors from the chassis assembly.

l. Removal of Fixed 30-Ohm Resistors (5, fig. D-3).

(1) Unsolder the wires from the three 30-ohm resistors and tag.

(2) Remove the two machine screws, lockwashers, and hexagon nuts that attach each resistor.

(3) Lift the resistors from the chassis assembly.

m. Removal of Fixed 40-Ohm Resistors (6, fig. D-3).

(1) Unsolder the wires from the three 40-ohm resistors and tag.

(2) Remove the two machine screws, lockwashers, and hexagon nuts that attach each resistor.

(3) Lift the resistor from the chassis assembly.

5-7. Disassembly of Printed Circuit Board Assembly

Remove the screws from the spacer (1, fig. D-4), angle (2), circuit board assemblies, (3, 5, 7, 9, 11 and 13), spacers (4, 6, 8, 10, and 12), and angle (14).

5-8. Reassembly of Printed Circuit Board Assembly

Place screws through angle (14, fig. D-4), spacers (12, 10, 8, 6, and 4), circuit board assemblies (13, 11, 9, 7, 5 and 3), angle (2), and spacer (1).

5-9. Reassembly of Chassis Assembly

a. Replacement of Fixed 40-Ohm Resistors.

(1) Position the three 40-ohm resistors (6, fig. D-3) on the chassis assembly.

(2) Place the two nuts for each resistor in machined surface in rear of mounting surface.

(3) Replace the six machine screws and lockwashers.

(4) Solder wires to the three resistors.

b. Replacement of Fixed 30-Ohm Resistors.

(1) Position the three 30-ohm resistors (5, fig. D-3) on the chassis assembly.

(2) Place the two nuts for each resistor in the machined surface in the rear of the mounting surface.

(3) Replace the six machine screws and lockwashers.

(4) Solder the wires to the three resistors.

c. Replacement of Fixed 20-Ohm Resistors.

(1) Position the three 20-ohm resistors (4, fig. D-3) on the chassis assembly.

(2) Place the two nuts for each resistor in the machined surface in the rear of the mounting surface.

(3) Replace the six machine screws and lockwashers.

(4) Solder the wires to the three resistors.

d. Replacement of Fixed 15-Ohm Resistors.

(1) Position the three 15-ohm resistors (3, fig. D-3) on the chassis assembly.

(2) Place the two nuts for each resistor in the machined surface in the rear of the mounting surface.

(3) Replace the six machine screws and lockwashers.

(4) Solder the wires to the three resistors.

e. Replacement of Choke.

(1) Position the choke (7, fig. D-3) on the chassis.

(2) Replace the four hexagon nuts and lockwashers on the mount bolts.

(3) Solder the wires to the choke terminals.

f. Replacement of Capacitor.

(1) Position the capacitor (10, fig. D-3) on the chassis.

(2) Replace the two machine screws, lockwashers, and hexagon nuts.

(3) Slide the clamp (11, fig. D-3) over the capacitor so that it rests on the chassis.

(4) Replace the two machine screws and hexagon nuts.

(5) Tighten the clamp and replace one machine screw, lockwasher, and hexagon nut.

(6) Solder the wires to the capacitor terminals.

g. Replacement of Electron Tube Socket.

(1) Insert the two machine screws with lockwashers through the electron tube socket (16, fig. D-3) and chassis. Replace the hexagon nuts on the screws.

(2) Solder the wires to the socket terminals.

(3) Reinstall the cable clamp.

(4) Insert the machine screw through the chassis and cable clamp.

(5) Replace the hexagon nut to the machine screw.

h. Replacement of Chopper.

(1) Insert the chopper (8, fig. D-3) into the electron tube socket (16, fig. D-3).

(2) Fasten the clamp (9, fig. D-3) around the chopper.

i. Replacement of Transformer.

(1) Place the transformer (1, fig. D-3) on the mounting bracket so that the smallest numbers (1, 2, 3, and 4) on its terminals are toward the printed circuit board assembly position.

(2) Replace the four lockwashers and hexagon nuts to the mount bolts.

(3) Solder the wires to the transformer terminals.

j. Replacement of Electron Tube Socket.

(1) Position the electron tube socket (15, fig. D–3) on the chassis.

(2) Insert the two machine screws with lockwashers through the chassis and the electron tube socket.

(3) Replace the two hexagon nuts.

(4) Solder the wires to the socket terminals.

k. Replacement of Relay.

(1) Insert the relay (14, fig. D–3) into the electron tube socket (15, fig. D–3).

(2) Position the two standoffs (13, fig. D–3) on chassis and insert the two machine screws with lockwashers.

(3) Position support (12, fig. D–3) on standoffs and insert two machine screws with lockwashers.

l. Replacement of Rectifier.

(1) Remove the nut and lockwasher from rectifier base and position rectifier (27, fig. D–3) on the chassis.

(2) Install the lug (28, fig. D–3) on the rectifier base and replace the lockwasher and nut.

(3) Solder the wires to the rectifier terminals.

m. Replacement of Magnetic Amplifier.

(1) Remove the hexagon nuts and lockwashers from the mounting studs.

(2) Position the magnetic amplifier (2, fig. D–3) on mount bracket and replace lockwashers and hexagon nuts to studs.

5–10. Replacement of Chassis Assembly

a. Replacement of Panel on Chassis.

(1) Position the panel (43, fig. D–2) on the chassis assembly (38, fig. D–2).

(2) Insert the six screws (39, fig. D–2) with lockwashers (40) through face of the panel into the chassis assembly.

b. Replacement of Holdown (22, fig. D–2).

(1) Remove the stop nut from the pivot pin and insert the pivot pin through the holdown and the panel.

(2) Replace the stop nut on the pivot pin.

c. Replacement of Variable Drive Assembly.

(1) Position the variable drive assembly (32, fig. D–2) on the rear of the panel.

(2) Install the six machine screws with lockwashers (33 and 34, fig. D–2) through the panel into the variable drive gear plate (37, fig. D–11).

(3) Solder the wires to the four terminals (36, fig. D–11) and the two terminals on tachometer generator (10, fig. D–11).

(4) Connect the connector (4, fig. D–11) to the second tachometer generator (5, fig. D–11).

d. Replacement of Test Pad Base (16, fig. D–2).

(1) Position the test pad base on panel.

(2) Install three machine screws with lockwashers.

e. Replacement of OUTPUT Toggle Switch.

(1) Position the OUTPUT toggle switch (12, fig. D–2) on the rear of the panel.

(2) Install the two machine screws with lockwashers.

(3) Attach the lugs to the switch terminals with screws.

f. Replacement of TERM CONN Rotary Switch.

(1) Position the TERM CONN rotary switch (6, fig. D–2) on the rear of the panel.

(2) Install the washer and hex nut on the switch mount shaft.

(3) Slide the knob (5, fig. D–2) onto the switch shaft.

(4) Tighten the setscrew in the knob.

(5) Solder the wires to the switch terminals.

g. Replacement of Voltmeter.

(1) Position the voltmeter (15, fig. D–2) on the front of the panel.

(2) Insert the three machine screws through the meter mount ring and panel. Install the lockwashers and hexagon nuts to three machine screws.

(3) Install the lugs to the meter terminals.

h. Replacement of INDICATOR Toggle Switch.

(1) Position the INDICATOR toggle switch (13, fig. D–2) on the rear of the panel.

(2) Install two machine screws with lockwashers.

(3) Connect the lugs to the switch terminals with screws.

i. Replacement of LOAD Rotary Switch.

(1) Position the LOAD rotary switch (8, fig. D–2) on the rear of the panel.

(2) Install the washer and hexagon nut on the switch mounting shaft.

(3) Slide the knob (7, fig. D–2) onto switch shaft.

(4) Tighten the setscrew in the knob.

(5) Solder the wires to the switch terminals.

j. Installation of Printed Circuit Board Assembly (fig. D-4).

(1) Install the bracket assembly (23, fig. D-3) to circuit board assembly No. 1 (fig. D-5) by installing two machine screws, lockwashers, and hexagon nuts.

(2) Position the printed circuit board assembly (fig. D-4) on the panel.

(3) Connect the bracket assembly to the chassis assembly by installing two machine screws, lockwashers, and hexagon nuts (18, 19, and 20, fig. D-3).

(4) Insert the two machine screws (41, fig. D-2) with lockwashers (42) through panel into spacers (1, fig. D-4).

(5) Insert two machine screws (21, fig. D-3) with lockwashers (22) through the chassis (32, fig. D-3) into the angle (2, fig. D-4).

(6) Insert two machine screws (21, fig. D-3) with lockwashers (22) through the chassis (32) into the second angle (14, fig. D-4).

(7) Solder the wires to the printed circuit board assembly.

k. Replacement of Variable Resistor (fig. D-2).

(1) Position the variable resistor (10) on the rear of the panel with the switch terminals toward the outside.

(2) Install two hexagon nuts with lockwashers on the variable resistor mount shaft.

(3) Slide the knob (9) onto the shaft and tighten the setscrew in the knob.

(4) Insert two screws with lockwashers through the chassis into spacer (11) and the variable resistor bracket.

(5) Solder the wires to the resistor terminals.

l. Replacement of Pivot, Decimal Arm, Spring, and Lug (fig. D-2).

(1) Insert ends of spring (26) through holes in lug (27) and decimal arm (25).

(2) Mount the pivot (24) to the rear of the panel (43) by inserting machine screw with lockwasher through the panel into the pivot.

(3) Mount the decimal arm (25) on the pivot (24) and install the retainer ring.

(4) Insert machine screw with lockwasher through the panel and lug (27) and install the hexagon nut on the machine screw.

m. Replacement of RANGE Rotary Switch (fig. D-2).

(1) Position the RANGE rotary switch (4) on the rear of the panel.

(2) Install the lockwasher and hexagon nut on the switch mount shaft.

(3) Slide the knob (3) onto the switch shaft.

(4) Tighten the setscrew in the knob.

(5) Solder the wires to the switch terminals.

n. Replacement of Window (fig. D-2).

(1) Position the gasket (30) on the panel (43).

(2) Position the window (29) on the gasket.

(3) Position the frame (28) over the window.

(4) Insert six machine screws with lockwashers through the frame into the panel.

o. Replacement of Digital Speed Indicator Assembly (fig. D-2).

(1) Position the digital speed indicator assembly (35) on the rear of the panel (43).

(2) Insert four machine screws with lockwashers (37) through the panel into the digital speed indicator assembly.

(3) Solder the wires to variable resistor (30, fig. D-12).

(4) Solder wires to magnetic amplifier (2, fig. D-3).

p. Replacement of Variable Resistor (fig. D-2).

(1) Position the variable resistor (2) on the rear of the panel with the resistor terminals toward the digital speed indicator assembly.

(2) Install two hexagon nuts on the resistor mount shaft.

(3) Slide the knob onto the resistor shaft.

(4) Tighten setscrew in knob.

(5) Solder the wires to the resistor terminals.

q. Replacement of POWER Toggle Switch (fig. D-2).

(1) Position the POWER toggle switch (18) on the rear of the panel.

(2) Install lockwasher and hexagon nut to the switch mount shaft.

(3) Connect the lugs to the switch terminals with screws.

r. Replacement of Fuse Holders.

(1) Position the fuse holder (20, fig. D-2) on front of the panel.

(2) Install lockwasher and hexagon nut to the base of the fuse holder.

(3) Solder the wires to the fuse holder terminals.

(4) Replace cartridge fuse (19, fig. D-2) into fuse holder and secure with the fuse holder end cap.

s. Replacement of Indicator Light.

(1) Position the indicator light on the front of the panel.

(2) Install the lockwasher and hexagon nut to the base of the indicator light (21, fig. D–2).

(3) Solder the wires to the indicator light terminals.

t. Replacement of Receptacle Connector.

(1) Position the receptacle connector (14, fig. D–2) on the front of the panel.

(2) Insert machine screws through the connector mount holes and install lockwashers and hexagon nuts to the screws.

(3) Solder the wires to the connector terminals.

NOTE

Replace all cable bundle ties that were removed during disassembly.

5–11. Replacement of Panel Assembly into Carrying Case Assembly

a. Set panel assembly (1) into case assembly (5).

NOTE

Use caution to prevent chafing of wire bundle against case.

b. Reinstall 14 screws with lockwashers through panel into case assembly.

c. Reinstall the shoulder screw (see attaching parts of panel assembly) through lid stay.

d. Install the locknut on the shoulder screw.

5–12. Calibration after Replacement

Replacement of components of the precision speed indicator circuit will necessitate a check of the tachometer tester calibration. Refer to chapter 6 for calibration check procedures.

5–13. Lubrication

Perform lubrication of test pad portion of drive assembly (para 4–9).

CHAPTER 6

GENERAL SUPPORT MAINTENANCE

6-1. Scope of General Support Maintenance

General support maintenance of the tachometer tester consists of calibrating the set. Paragraphs 6-2 through 6-6 cover the calibration check, test equipment required, equipment setup, and check procedures.

6-2. Calibration Check

Calibration is required only of the MASTER INDICATOR control circuitry. Scale calibrations on indicator ranges RPM X 1, RPM X 2, and RPM PERCENT is effected with trimming potentiometers R26, R27, and R28 respectively. Control amplifier output is nulled with zero input signal through adjustment of the amplifier balance control R13. These adjustments are all internal to the tachometer tester, located on the lower circuit board. Should feedback potentiometer R29 of the indicator positional servo be replaced or repairs be made to the MASTER INDICATOR drive gearing, a zero alignment of R29 in respect to the MASTER INDICATOR counter must be performed. The need for tachometer tester calibration is determined in the manner set forth in paragraph 6-5.

6-3. Test Equipment Required

Test equipment required for calibration of the tachometer tester is listed in table 6-1.

Table 6-1. Test Equipment

Nomenclature	Purpose	Common Name
Audio Generator AN/URM-127.	Simulate tachometer input voltage.	Audio oscillator
Frequency Meter AN/TSM-16.	Precision adjustment of input frequency (time period).	Frequency meter
Multimeter TS-352B/U.	General purpose...	Multimeter

6-4. Equipment Setup

Connect equipment (fig. 6-1) as described below.

a. Connect the POWER INPUT jack to a 115-volt, 400-Hz single-phase power source through the powerline connector cable.

b. Position tachometer tester controls and allow warm up as in paragraph 3-3.

c. Set POWER switch to ON.

d. Set INDICATOR switch to TEST GEN.

e. Allow a 5-minute warmup.

f. Connect audio oscillator output to TEST GEN INPUT jack. The ground side of the audio oscillator is connected to pin C and the high side connected to pin A of this jack. Turn on the audio oscillator and allow warm up interval as specified in operations manual of audio oscillator.

g. Connect frequency meter input across audio oscillator output. Set controls to allow a frequency period measurement of 0.012000 seconds ±0.01%. Turn power control on and allow warm up for interval specified in operations manual of frequency meter.

6-5. Check Procedure

Calibration is required if the tachometer tester does not exhibit the accuracy tabulated in table 6-2 when subjected to the associated test. The output level of the audio oscillator is set to a value sufficient to cause an indication on the MASTER INDICATOR.

6-6. Calibration Procedure

Calibration of the tachometer tester consists of the procedures listed in the following tests:

a. Control Amplifier Balance.

(1) Remove power from system.

(2) Remove the panel assembly from the carrying case.

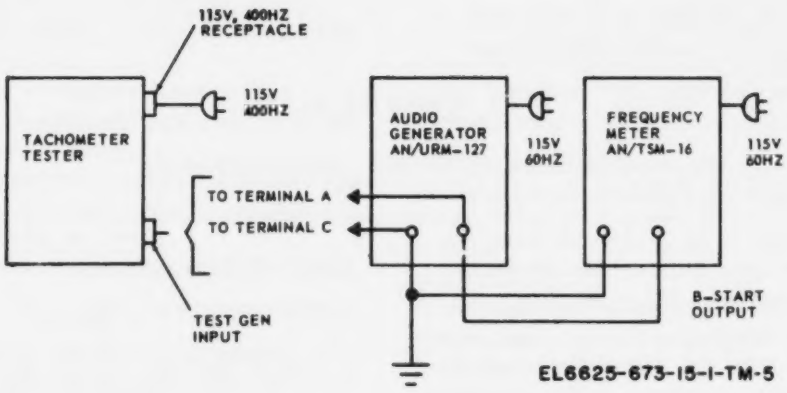

Figure 6-1. Equipment setup.

(3) Set the tachometer tester controls as follows:

(*a*) INCREASE SPEED control ---------- Fully ccw
(*b*) RANGE switch ----- RPM X 1
(*c*) INDICATOR switch-- OFF
(*d*) LOAD switch ------- OFF
(*e*) TERM CONN switch- Any position
(*f*) OUTPUT switch ---- OFF
(*g*) MASTER GEN OUTPUT control -- Fully ccw

(4) Set POWER switch to ON.

(5) Set INDICATOR switch to MASTER GEN.

(6) Allow 5 minutes for warm up.

(7) Rotate INCREASE SPEED control until the MASTER INDICATOR reads approximately 200 rpm.

(8) Return INCREASE SPEED control to fully ccw position.

(9) Adjust amplifier balance control R13 for a zero rpm display on the MASTER INDICATOR.

(10) Repeat steps (7), (8), and (9) to assure a return to zero rpm display on the MASTER INDICATOR.

b. Scale Calibration.

(1) Remove power from system.

(2) Set tachometer tester controls as follows:

(*a*) INCREASE SPEED control ---------- Fully ccw
(*b*) RANGE switch ----- RPM X 1
(*c*) INDICATOR switch-- OFF
(*d*) LOAD switch ------- OFF
(*e*) TERM CONN switch - Any position
(*f*) OUTPUT switch ----- OFF
(*g*) MASTER GEN OUTPUT control -- Fully ccw

(3) Set POWER switch on the tachometer tester to ON.

(4) Set INDICATOR switch to TEST GEN

(5) Allow 5-minute warmup.

(6) Adjust the audio oscillator for an output of 83.33 Hz as indicated by a period of 0.012000±.000120 seconds on the frequency meter.

(7) Connect the audio oscillator output to TEST GEN INPUT jack as in paragraph 6-4*f*.

(8) Increase the audio oscillator output control until the MASTER INDICATOR control circuits cause an indication on the MASTER INDICATOR.

(9) Adjust potentiometer R26 for a reading of 5000 rpm on the MASTER INDICATOR.

(10) Rotate RANGE switch to RPM X 2 position. Adjust potentiometer R27 for a reading of 10,000 rpm on the MASTER INDICATOR.

(11) Rotate RANGE switch to RPM PER-

Table 6-2. Calibration Checkpoints

AN/URM-127 frequency	Period of frequency AN/TSM-16	MASTER INDICATOR		
		RPM X 1	RPM X 2	RPM PERCENT
83.33 Hz	0.012000 Seconds	4990 to 5010	9980 to 10020	118.80 to 119.20
56.00 Hz	0.017857 Seconds	3350 to 3370	6700 to 6740	79.80 to 80.20
28.00 Hz	0.035714 Seconds	1670 to 1690	3340 to 3380	39.80 to 40.20

CENT position. Adjust potentiometer R28 for a reading of 119.00 percent on the MASTER INDICATOR.

(12) Check calibrations in accordance with table 6-2.

(13) Indicator error is minimized at the three checkpoints on each of the three display ranges by readjusting potentiometers R26, R27, and R28 for the display RPM X 1, RPM X 2, and RPM PERCENT respectively.

c. Zero Alignment (fig. D-12). Perform this alignment only after replacement of potentiometer R29 or after effecting repairs to the MASTER INDICATOR drive gearing. Zero alignment sets potentiometer R29 at minimum resistance from center arm to ground terminal when the MASTER INDICATOR displays 00000.

(1) Loosen miter gear (1) and slide until disengaged from mitre gear (37) on MASTER INDICATOR counter (35).

(2) Manually turn MASTER INDICATOR counter to 00000.

(3) Set multimeter to measure resistance and connect multimeter to center arm and ground terminal of potentiometer R29.

(4) Manually set potentiometer R29 to minimum resistance as indicated on multimeter. Potentiometer rotation is effected by rotation of spur gear (5).

(5) With R29 at minimum resistance and counter set at 00000, engage miter gear (1) and tighten securely on spur gear shaft (19).

CHAPTER 7

DEPOT MAINTENANCE

Section I. GENERAL

7-1. Depot Overhaul

Complete rebuild of the tachometer tester or its individual components may be accomplished by depot maintenance. Rebuild action will include all repair, rebuild, and replacement operations necessary to make the equipment suitable for reissue. Detailed procedures for accomplishing the repairs and adjustments established in the proceeding portions of this manual and such additional repair and rebuild operations as deemed necessary, will be established by the facility performing the work. The depot overhaul standards (DOS) establish the requirements that *must be met* by rebuilt or repaired equipment before it can be reissued or placed in supply system stocks.

7-2. General Parts Replacement Techniques

Before removing a part in the tachometer tester or its assemblies, note the position of the part and its leads. Install replacement parts in the same position as the originals to avoid undesired results.

7-3. Replacement of Parts

In addition to removal and replacement procedures performed by lower categories (paras 5-3 through 5-11), depot maintenance personnel may replace all parts of the variable drive assembly and digital speed indicator assembly. Complete disassembly of the variable drive assembly is illustrated in figure D-11. Complete disassembly of the digital speed indicator assembly is illustrated in figure D-12.

7-4. Equipment Adjustments and Mechanical Synchronization

The only adjustments and mechanical synchronizations made on the TTU-27/E are those required during performance of the zero alignment procedures covered in paragraph 6-6*c*.

Section II. DEPOT OVERHAUL STANDARDS

7-5. Applicability of Depot Overhaul Standards

This standard covers inspection requirements to be used in determining the quality and acceptability of a repaired tachometer tester. Equipment that is to be reissued or returned to supply system stocks must meet the standards given in these tests.

7-6. Applicable References

Depot inspection standards and technical publications available to the repairmen are listed in appendix A.

7-7. Modification Work Orders

DA Pam 310-7 lists all available MWO's. Perform all modification work orders applicable to the TTU-27/E before making tests specified.

7-8. Test Facilities Required

In addition to the facilities and test equipment listed in paragraph 6-3, an Electronic Voltmeter, ME-26B/U or equivalent (hereafter called the electronic voltmeter) is required.

7-9. General Test Conditions

All tests shall be conducted under the following conditions:

a. Set the tachometer tester controls as follows:

(1) INCREASE SPEED control	Fully ccw
(2) RANGE switch	RPM X 1
(3) INDICATOR switch	OFF
(4) LOAD switch	OFF
(5) TERM CONN switch	Any position

(6) OUTPUT switch ..... OFF
(7) MASTER GEN
OUTPUT control .... Fully ccw

b. Connect the tachometer tester to a 115-volt, 400-Hz, single-phase power source capable of supplying at least 250 volt-amperes and connect the power cable ground lead to electrical ground. Set the POWER switch to ON and allow 30 minutes for temperature to stabilize.

7-10. Specific Tests

a. Rpm MASTER INDICATOR accuracy test.

(1) Set the tachometer tester controls as follows:

(*a*) INCREASE SPEED control ..... Fully ccw
(*b*) RANGE switch ..... RPM X 1
(*c*) INDICATOR switch .. TEST GEN
(*d*) LOAD switch ..... OFF
(*e*) TERM CONN switch . Any position
(*f*) OUTPUT switch .... OFF
(*g*) MASTER GEN OUTPUT control .. Fully ccw

(2) Connect the audio oscillator output terminals to the frequency meter input connector and to pins A and C of the tachometer tester TEST GEN INPUT jack. Pin C is ground.

(3) Adjust the frequency meter for making time interval measurements with a 10^{-6} period average.

(4) Adjust the audio oscillator output for 5 volts ±10 percent at each of the frequencies listed below. The MASTER INDICATOR must read within the listed limits.

Oscillator frequency (Hz)	*Counter (seconds)*	*RPM X 1*
20	0.050000	1190 to 1210
35	0.028571	2090 to 2110
50	0.020000	2990 to 3010
70	0.014286	4190 to 4210
83.3	0.012000	4990 to 5010

(5) Adjust the audio oscillator frequency for an indication of 2100 on the MASTER INDICATOR (with the RANGE switch still set at RPM X 1). Then set the Range switch to RPM X 2. The new addition must be 4200. Then set the Range switch to RPM PERCENT; the MASTER INDICATOR must now indicate 050.0.

(6) Disconnect the audio oscillator and frequency meter.

b. Tachometer Tester Output Voltage.

(1) Connect the electronic voltmeter between pins A and C of the tachometer tester master GEN OUTPUT jack.

(2) Adjust the tachometer tester controls as follows:

(*a*) TERM CONN switch ..... A–C
(*b*) INDICATOR switch ..... MASTER GEN
(*c*) OUTPUT switch .. MASTER GEN
(*d*) MASTER GEN OUTPUT control .. Fully ccw

(3) Rotate INCREASE SPEED control clockwise until MASTER INDICATOR reads 3600 with RANGE switch at RPM X 1.

(4) Rotate the MASTER GEN OUTPUT control clockwise to obtain each of the indications listed below and verify that the electronic voltmeter indication is within the corresponding limits at each setting.

Test set (volts)	*Electronic voltmeter (volts)*
10	9.4 to 10.6
20	19.4 to 20.6
30	29.4 to 30.6

(5) Rotate the MASTER GEN OUTPUT control and INCREASE SPEED control fully counter clockwise and set INDICATOR switch to OFF. Disconnect the 115-volt, 400-Hz power and the electronic voltmeter.

c. Load Resistance Test. Set the tachometer tester LOAD switch to positions indicated below. At each position, measure the resistance between pins A and B, A and C, and B and C of the tachometer tester TEST GEN INPUT jack and verify that the multimeter indications are within the listed limits.

LOAD (ohms)	*Multimeter reading (ohms)*
15	8 to 10 ohms
30	16 to 24 ohms
20	32 to 48 ohms
40	64 to 96 ohms

APPENDIX A

REFERENCES

Following is a list of applicable references available to the operator and repairman of the TTU-27/E.

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, Lubrication Orders, and Modification Work Orders.
DA Pam 310-7	Index of Modification Work Orders.
TB SIG 355-1	Depot Inspection Standard for Repaired Signal Equipment.
TB SIG 355-2	Depot Inspection Standard for Refinishing Repaired Signal Equipment.
TB SIG 355-3	Depot Inspection Standard for Moisture and Fungus Resistant Treatment.
TB 746-10	Field Instructions for Painting and Preserving Electronics Command Equipment.
TM 11-5102	Resistors, Decade ZM-16/U, ZM-16A/U, and ZM-16B/U.
TM 11-6625-366-15	Multimeter TS-352B/U.
TM 11-6625-200-15	Operator and Organizational Maintenance Manual: Multimeters ME-26A/U, ME-26B/U, and ME-26C/U.
TM 11-6625-203-12	Operator and Organizational Maintenance: Multimeter AN/URM-105, Including Multimeter ME-77/U.
TM 11-6625-218-22	Organizational Maintenance Manual: Frequency Meter AN/TSM-16.
TM 11-6625-274-12	Operator's and Organizational Maintenance Manual: Test Sets, Electron Tube TV-7/U, TV-7A/U, and TV-7B/U, and TV-7D/U.
TM 11-6625-316-12	Operator's and Organizational Maintenance Manual: Test Sets, Electron Tube TV-2/U, TV-2A/U, TV-2B/U, and TV-2C/U.
TM 11-6625-535-15-1	Organizational, DS, GS and Depot Maintenance Manual: Oscilloscopes AN/USM-140B, AN/USM-140C, AN/USM-141A, and AN/USM-141B.
TM 11-6625-683-15	Operator, Organizational Direct Support, General Support, and Depot Maintenance Manual: Signal Generator AN/URM-127.
TM 38-750	The Army Maintenance Management System (TAMMS).

APPENDIX C
MAINTENANCE ALLOCATION

Section I. INTRODUCTION

C-1. General

This appendix provides a summary of the maintenance operations for the TTU-27/E. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

C-2. Maintenance Function

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean, preserve, drain, paint, or to replenish fuel/lubricants/hydraulic fluids or compressed air supplies.

d. Adjust. Maintain within prescribed limits by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. Align. To adjust specified variable elements of an item to about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipment used in precision measurement. Consists of the comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment/system.

h. Replace. The act of substituting a serviceable like-type part, subassembly, model (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module/component/assembly, end item or system. This function does not include the trial and error replacement of running spare type items such as fuses, lamps, or electron tubes.

j. Overhaul. That periodic maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (e.g., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like-new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like-new condition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc) considered in classifying Army equipment/components.

C-3. Column Entries

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies and modules with the next higher assembly.

b. Column 2, Component/Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the item listed in column 2. When items are listed without maintenance functions, it is solely for purpose of having the group numbers in the MAC and RPSTL coincide.

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a "worktime" figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "worktime" figures will be shown for each category. The number of man-hours

specified by the "worktime" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

C — Operator/Crew
O — Organizational
F — Direct Support
H — General Support
D — Depot

e. Column 5, Tools and Equipment. Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

C-4. Tool and Test Equipment Requirements (Table 1)

a. Tool or Test Equipment Reference Code. The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. Maintenance Category. The codes in this column indicate the maintenance category allocated the tool or test equipment.

c. Nomenclature. This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Tool Number. This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for manufacturers (5-digit) in parentheses.

SECTION II MAINTENANCE ALLOCATION CHART
FOR
TEST SET, INDICATOR-GENERATOR, TACHOMETER TTU-27/E
CONTRACT NUMBER F41608-67-C-7762

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQUIPMENT
			C	O	F	H	D	
00	TEST SET, INDICATOR-GENERATOR, TACHOMETER TTU-27/E, CONTRACT NUMBER F41608-67-C-7762	Inspect	0.1					
		Test			0.1			
		Service		0.2				
		Adjust[1]			0.1			
		Calibrate				0.5		
		Repair[2]		0.2				3,4,5
		Repair[3]			0.5			1,2,6 thru 13
		Repair[4]				1.5		1,2,6 thru 13
		Repair[5]					2.0	1,2,6 thru 13
		Overhaul					30.0	
01	GROUP, PANEL ASSEMBLY	Calibrate				0.5		
		Repair[2]		0.2				3,4,5
		Repair[3]			0.5			1,2,6 thru 13
		Repair[4]				1.5		1,2,6 thru 13
		Repair[5]					2.0	1,2,6 thru 13
0101	VARIABLE DRIVE ASSEMBLY	Service[6]			0.2			
		Replace			0.5			1,2,6 thru 13
		Repair[5]					1.0	1,2,6 thru 13
0102	INDICATOR ASSEMBLY, DIGITAL, SPEED	Test				0.1		
		Replace				0.4		1,2,6 thru 13
		Repair[5]					2.0	1,2,6 thru 13
0103	CHASSIS ASSEMBLY	Test			0.2			
		Repair[5]			1.5			1,2,6 thru 13
010301	PRINTED CIRCUIT BOARD ASSEMBLY	Test			0.2			
		Repair[5]			0.6			1,2,6 thru 13
01030101 THRU 01030106	PRINTED CIRCUIT BOARDS 1 THRU 6	Test			0.2			
		Repair[5]			0.5			1,2,6 thru 13
010302	CHASSIS	Test			0.2			
		Repair[3]			1.5			1,2,6 thru 13
02	GROUP, CABLE ASSEMBLIES	Test		0.2				
		Replace		0.1				3,4,5
		Repair			0.5			1,6,7
0201 THRU 0207	CABLE ASSEMBLY B667-367 THRU B667-372 AND CABLE, 3 CONDUCTOR	Test		0.2				
		Replace		0.1				3,4,5
		Repair			0.5			1,6,7
03	GROUP, CASE ASSEMBLY	Service		0.2				5
		Replace[7]			0.2			6,7

(1) Zero Meters.
(2) Repair limited to replacement of easily accessible fuses and knobs and replacement of defective cables.
(3) Repair by replacing subassemblies and chassis-mounted components.
(4) Repair wiring harness.
(5) Troubleshoot and repair.
(6) Lubricate test pad portion of drive assembly.
(7) No repair; replace if damaged.

TABLE 1. TOOL AND TEST EQUIPMENT REQUIREMENTS
FOR

TEST SET, INDICATOR-GENERATOR, TACHOMETER TTU-27/E
CONTRACT NUMBER F41608-67-C-7762

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1	F,H,D	MULTIMETER AN/USM-223	6625-00-999-7465	
2	F,H,D	MULTIMETER ME-26B/U	6625-00-646-9409	
3	O	MULTIMETER AN/URM-105	6625-00-581-2036	
4	O	MAINTENANCE KIT, ELECTRONIC EQUIPMENT MK-693A	5821-00-043-9695	
5	O	TOOL KIT, ELECTRONIC EQUIPMENT TK-101/G	5180-00-064-5178	
6	F,H,D	TOOL KIT, ELECTRONIC EQUIPMENT TK-100/G	5180-00-605-0079	
7	F,H,D	TOOL KIT, ELECTRONIC EQUIPMENTTK-105/G	5180-00-610-8177	
8	F,H,D	TEST SET, ELECTRON TUBE TV-2/U	6625-00-669-0263	
9	F,H,D	TEST SET, ELECTRON TUBE TV-7D/U	6625-00-820-0064	
10	F,H,D	OSCILLOSCOPE AN/USM-281	6625-00-053-3112	
11	F,H,D	OSCILLATOR, AUDIO TS-312A	6625-00-806-5011	
12	F,H,D	FREQUENCY METER AN/TSM-16	6625-00-542-1066	
13	F,H,D	RESISTOR, DECADE ZM-16	6625-00-669-0256	

APPENDIX D

PARTS LOCATION DIAGRAMS

Figure and index No.	Description
	TEST SET, INDICATOR-GENERATOR, TACHOMETER TTU-27/E
D-1-	TEST SET, INDICATOR-GENERATOR, TACHOMETER, TTU-27/E
-1	PANEL ASSEMBLY (See figure D-2 for breakdown.) (ATTACHING PARTS)
	SCREW
	LOCKWASHER
	SCREW, Shoulder
	NUT, Lock
-2	GASKET
-3	LID STAY ASSEMBLY
	(ATTACHING PARTS)
	RIVET
	HANDLE (84971)
	(ATTACHING PARTS)
	RIVET
	NAMEPLATE
	(ATTACHING PARTS)
	SCREW, Drive
-4	PLATE, Instruction
-5	CASE ASSEMBLY
-6	LID STAY ASSEMBLY
	(ATTACHING PARTS)
	RIVET
-7	SCREW, Shoulder
-8	NUT, Lock
-9	BASE
	(ATTACHING PARTS)
	RIVET, Blind
-10	FASTENER, Link-lock (82240)
	(ATTACHING PARTS)
	RIVET
	RIVET
-11	CABLE ASSEMBLY B667-367
	CONNECTOR
	CONNECTOR
	CLAMP, Cable
	CLAMP, Cable
-12	CABLE ASSEMBLY B667-368
	CONNECTOR
	CONNECTOR
	CLAMP, Cable
	CLIP, Alligator (76545)
-13	CABLE ASSEMBLY B667-369
	CONNECTOR
	CLAMP, Cable
-14	CABLE ASSEMBLY B667-370
	CONNECTOR
	CLAMP, Cable
-15	CABLE ASSEMBLY B667-371
	CONNECTOR
	CLAMP, Cable
-16	CABLE ASSEMBLY B667-372
	CONNECTOR
	CLAMP, Cable
	CLIP (71002)
	LUG, Terminal
-17	CABLE ASSEMBLY, Adapter B667-374
	CONNECTOR
	CONNECTOR
	CLAMP, Cable
-18	CABLE ASSEMBLY, Adapter B667-375
	CONNECTOR
	CONNECTOR
	CLAMP, Cable
	PANEL ASSEMBLY
D-2-	PANEL ASSEMBLY (See figure D-1 for next higher assembly.)
-1	KNOB (99813)
	(ATTACHING PARTS)
	SETSCREW, Hex. Soc., Cup Pt., Stl No. 8-32 x ¼ (supplied with item 1)
-2	RESISTOR, Variable (11534)
	(ATTACHING PARTS)
	NUT, Hex., Stl. No. ⅜-32 (suplied with item 2)
	NUT, Hex., Stl. No. ⅜-32 (97539)
-3	KNOB (24655)
	(ATTACHING PARTS)
	SETSCREW, Hex. Soc., Cup Pt., Stl. No. 10-32 x ¼ (supplied with item 3)
-4	SWITCH, Rotary
	(ATTACHING PARTS)
	NUT. Hex., Stl. No. ⅜-32 (supplied with item 4)
	LOCKWASHER, Stl. ⅜ (supplied with item 4)
-5	KNOB (24655)
	(ATTACHING PARTS)
	SETSCREW, Hex. Soc., Cup Pt., Stl. No. 10-32 x ¼ (supplied with item 5)
-6	SWITCH, Rotary (54294)
	(ATTACHING PARTS)
	NUT, Hex., Stl. ⅜-32 (supplied with item 4)
	LOCKWASHER, Stl. ⅜ (supplied with item 4)
-7	KNOB (24655)
	(ATTACHING PARTS)
	SETSCREW, Hex. Soc., Cup Pt., No. 10-32 x ¼ (supplied with item 7)

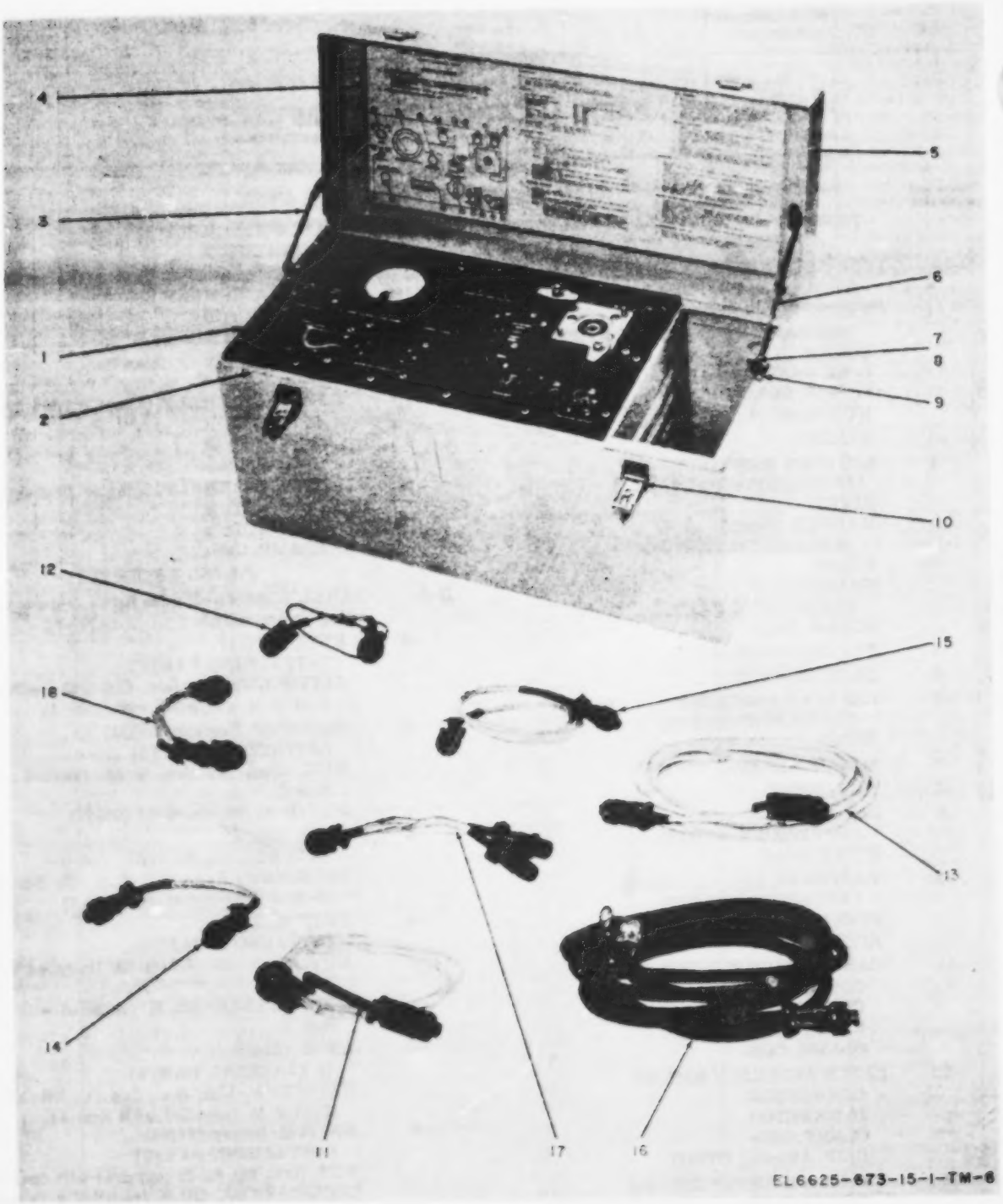

Figure D-1. Test Set, Indicator-Generator, Tachometer TTU-27/E.

Figure and index No.	Description
-8	SWITCH, Rotary (54294)
	(ATTACHING PARTS)
	NUT, Hex., Stl. No. 8-32 (supplied with item 8)
	LOCKWASHER, Stl. # (supplied with item 8)
-9	KNOB (24655)
	(ATTACHING PARTS)
	SETSCREW, Hex. Soc., Cup Pt., Stl. No. 10-32 x 1/4 (supplied with item 9)
-10	RESISTOR, Variable
	(ATTACHING PARTS)
	NUT, Hex., Stl. No. 8-32 (supplied with item 10)
	LOCKWASHER, Stl. # (supplied with Item 10)
-11	SPACER
	(ATTACHING PARTS)
	LOCKWASHER
	SCREW
-12	SWITCH, Toggle
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
-13	SWITCH, Toggle
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
-14	CONNECTOR, Receptacle
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	NUT, Hexagon
-15	VOLTMETER
	(ATTACHING PARTS)
	SCREW, Machine, rd. hd. steel, 6-32 x 3/8 lg. (supplied with item 14)
	LOCKWASHER, Steel No. 6 (supplied with item 14)
	NUT, Hex., Steel No. 6-32 (supplied with item 14)
-16	BASE
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
-17	PIN, Guide
-18	SWITCH, Toggle
-19	FUSE, Cartridge, 4 amp 3 AG (75915)
-20	FUSE HOLDER (75915)
	(ATTACHING PARTS)
	NUT, Hex., Stl. 1/2-16 (supplied with item 20)
	LOCKWASHER, Stl. 1/2 (supplied with item 20)
-21	LIGHT, Indicator (05402)
	(ATTACHING PARTS)
	NUT, Hexagon, 15/32-32 (supplied with item 21)
	LOCKWASHER, (supplied with item 21)
-22	HOLDOWN
	(ATTACHING PARTS)
	NUT, Stop, 1/4-20 (72962)
	WASHER, Spring (78189)
-23	PIN, Pivot
	(ATTACHING PARTS)
	NUT, Stop, 1/4-20 (72962)
-24	PIVOT
-25	DECIMAL ARM
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	RING, Retaining
-26	SPRING
-27	LUG
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	NUT, Hexagon
-28	FRAME, Window
-29	WINDOW
-30	GASKET
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
-31	BASE
	(ATTACHING PARTS)
	RIVET
-32	VARIABLE DRIVE ASSEMBLY (See figure D-11 for breakdown.)
	(ATTACHING PARTS)
-33	SCREW, Machine
-34	LOCKWASHER
-35	INDICATOR ASSEMBLY, DIGITAL SPEED (See figure D-12 for breakdown.)
	(ATTACHING PARTS)
-36	SCREW, Machine
-37	LOCKWASHER
-38	CHASSIS ASSEMBLY (See figure D-3 for breakdown.)
	(ATTACHING PARTS)
-39	SCREW, Machine
-40	LOCKWASHER
-41	SCREW, Machine
-42	LOCKWASHER
-43	PANEL
	CHASSIS ASSEMBLY
D-3-	CHASSIS ASSEMBLY (See figure D-2-38 for next higher assembly.)
	TRANSFORMER
-1	TRANSFORMER
	(ATTACHING PARTS)
	NUT, Hexagon
	LOCKWASHER
-2	AMPLIFIER, Magnetic (88818)
	(ATTACHING PARTS)
	NUT, Hexagon
	LOCKWASHER
-3	RESISTOR, Fixed 15 ohm 50 W (00213)
-4	RESISTOR, Fixed 20 ohm 50 W (00213)
-5	RESISTOR, Fixed 30 ohm 50 W (00213)

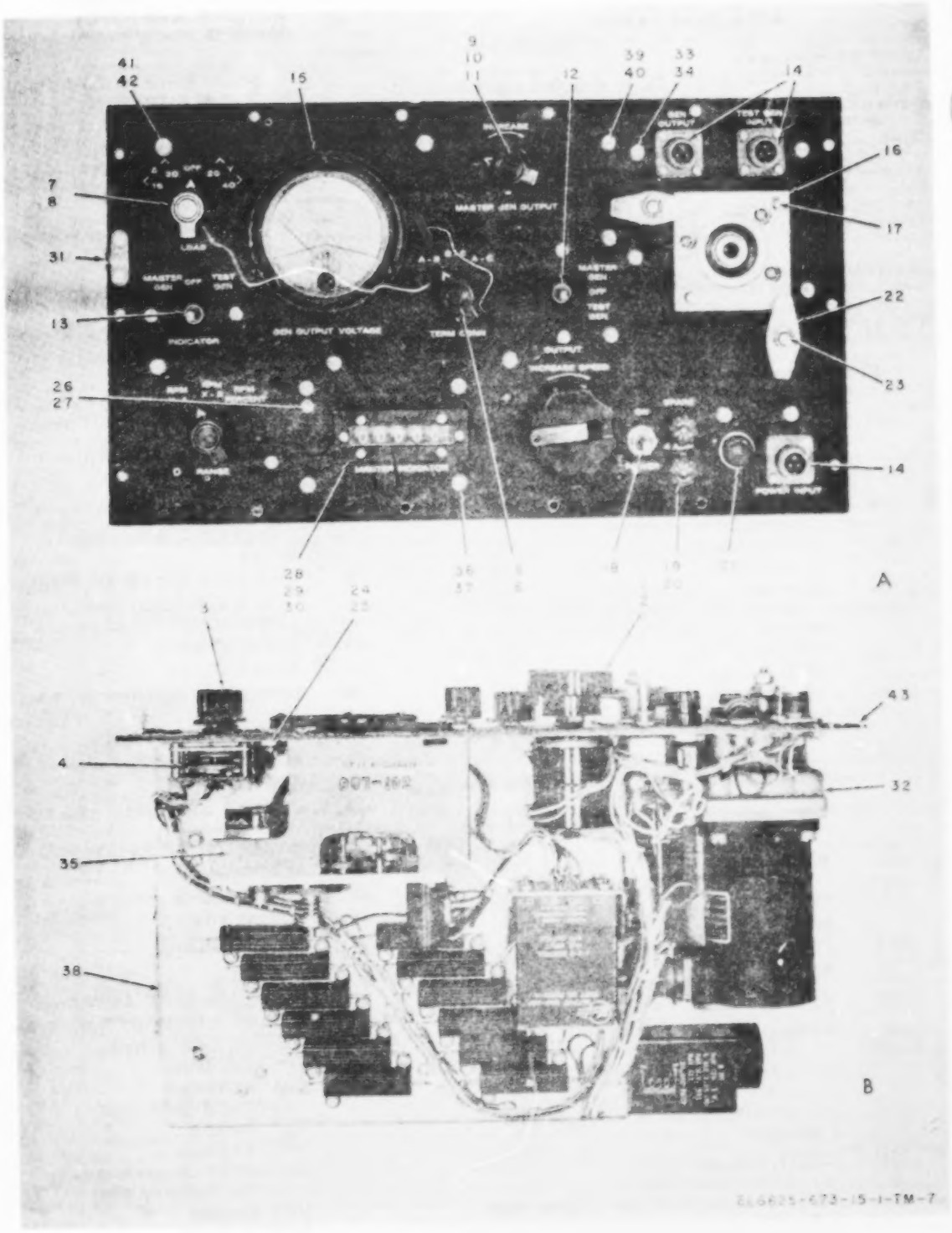

Figure D-2. Panel assembly.

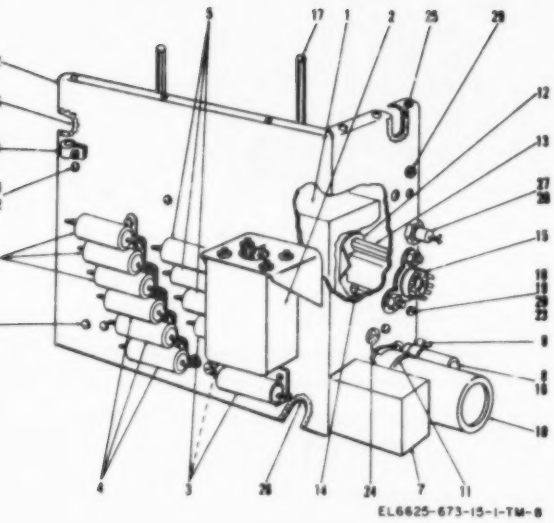

Figure D-3. Chassis assembly.

Figure and index No.	Description
-6	RESISTOR, Fixed 40 ohm 50 W (00213)
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	NUT, Hexagon
-7	CHOKE
	(ATTACHING PARTS)
	NUT, Hexagon
	LOCKWASHER
-8	CHOPPER (12749)
-9	CLAMP (07387)
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	NUT, Hexagon
-10	CAPACITOR, Fixed 100 mfd 450 V (14655)
	(ATTACHING PARTS
	SCREW, Machine
	LOCKWASHER
	NUT, Hexagon
-11	CLAMP (14655)
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	NUT, Hexagon
	SCREW, Machine
-12	SUPPORT
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
-13	STANDOFF
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
-14	RELAY (78277)
-15	SOCKET, Electron Tube
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	NUT, Hexagon
-16	SOCKET, Electron Tube
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	NUT, Hexagon
-17	PRINTED CKT BD ASSY (See figure D-4 for breakdown.)
	(ATTACHING PARTS)
-18	SCREW, Machine
-19	LOCKWASHER
-20	NUT, Hexagon
-21	SCREW, Machine
-22	LOCKWASHER
-23	BRACKET
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	NUT, Hexagon
-24	GROMMET (83330)
-25	GROMMET (03296) $1\frac{13}{17}$ LG
-26	GROMMET (03296) $2\frac{13}{16}$ LG
-27	RECTIFIER
-28	LUG, Terminal
	(ATTACHING PART)
	NUT, Hexagon No. 10-32, Steel (supplied with item 27)
-29	CLAMP, Cable (09922)
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	NUT, Hexagon
-30	CLAMP, Cable (09922)
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
-31	CLAMP, Cable (09922)
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	NUT, Hexagon
-32	CHASSIS
	PRINTED CIRCUIT BOARD ASSEMBLY
D-4-	PRINTED CIRCUIT BOARD ASSEMBLY (See figure D-3-17 for next higher assembly.)
-1	SPACER
-2	ANGLE
-3	CIRCUIT BOARD ASSEMBLY, No. 6 (See figure D-10 for breakdown.)
-4	SPACER
-5	CIRCUIT BOARD ASSEMBLY, No. 5 (See figure D-9 for breakdown.)
-6	SPACER
-7	CIRCUIT BOARD ASSEMBLY, No. 4 (See figure D-8 for breakdown.)
-8	SPACER

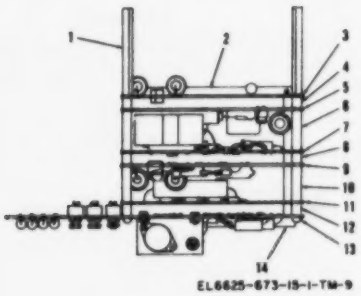

Figure D-4. Printed circuit board assembly.

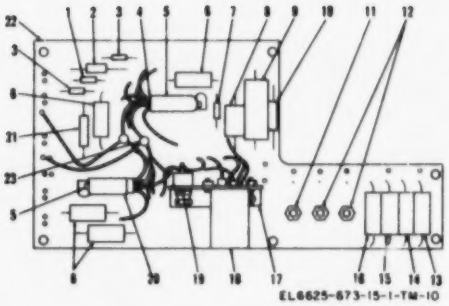

Figure D-5. Circuit board assembly No. 1

Figure and index No.	Description
-9	CIRCUIT BOARD ASSEMBLY, No. 3 (See figure D-7 for breakdown.)
-10	SPACER
-11	CIRCUIT BOARD ASSEMBLY, No. 2 (See figure D-6 for breakdown.)
-12	SPACER
-13	CIRUIT BOARD ASSEMBLY, No. 1 (See figure D-5 for breakdown.)
-14	ANGLE (ATTACHING PARTS) SCREW LOCKWASHER

CIRCUIT BOARD ASSEMBLY

D-5-	CIRCUIT BOARD ASSEMBLY No. 1 (See figure D-4-13 for next higher assembly.)
-1	RESISTOR, Fixed
-2	CAPACITOR, Fixed
-3	RESISTOR, Fixed
-4	ELECTRON TUBE
-5	MOUNT, Shield (99789) (ATTACHING PARTS) EYELET (04264)
-6	CAPACITOR, Fixed
-7	RESISTOR, Fixed
-8	CAPACITOR, Fixed
-9	CAPACITOR, Fixed
-10	RESISTOR, Fixed
-11	RESISTOR, Variable 50K ohm (02297) (ATTACHING PARTS) LOCKWASHER, Stl. ¼ in. (supplied with item 11) NUT, Hexagon Stl. No. ¼-32 (supplied with item 11)
-12	RESISTOR, Variable 100K ohm (02297) (ATTACHING PARTS) LOCKWASHER, Stl. ¼ in. (supplied with item 12) NUT, Hexagon Stl. No. ¼-32 (supplied with item 12)
-13	RESISTOR, Fixed
-14	RESISTOR, Fixed
-15	RESISTOR, Fixed
-16	RESISTOR, Fixed
-17	TRANSFORMER BRACKET SUB-ASSEMBLY (ATTACHING PARTS) SCREW, Machine LOCKWASHER NUT, Hexagon
-18	TRANSFORMER (80223) (ATTACHING PARTS) SCREW, Machine LOCKWASHER NUT, Hexagon
-19	RESISTOR, Variable 500 ohm (02297) (ATTACHING PARTS) LOCKWASHER, Stl. ¼ in. (supplied with item 19) NUT, Hexagon Stl. No. ¼-32 (supplied with item 19)
-20	ELECTRON TUBE
-21	CAPACITOR, Fixed
-22	BOARD, Printed circuit
-23	STANDOFF (98291)

CIRCUIT BOARD ASSEMBLY No. 2

D-6-	CIRCUIT BOARD ASSEMBLY No. 2 (See figure D-4-11 for next higher assembly.)
-1	CAPACITOR, Fixed
-2	CLAMP, Loop (ATTACHING PARTS) SCREW, Machine LOCKWASHER WASHER, Flat NUT, Hexagon
-3	CAPACITOR, Fixed
-4	CLAMP, Loop (ATTACHING PARTS) SCREW, Machine LOCKWASHER WASHER, Flat NUT, Hexagon
-5	RESISTOR, Fixed
-6	RESISTOR, Fixed
-7	CAPACITOR
-8	BOARD, Printed circuit

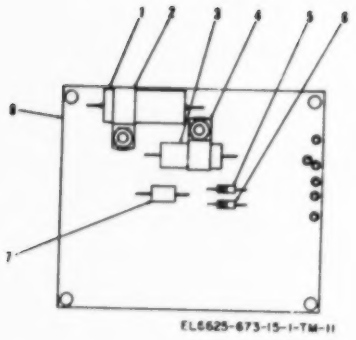

Figure D-6. Circuit board assembly No. 2

Figure and index No.	*Description*
	CIRCUIT BOARD ASSEMBLY No. 3
D-7-	CIRCUIT BOARD ASSEMBLY No. 3 (See figure D-4-9 for next higher assembly)
-1	RESISTOR, Fixed
-2	RECTIFIER, Silicon
-3	CAPACITOR, Fixed
-4	CLAMP, Loop
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	WASHER, Flat
	NUT, Hexagon
-5	CAPACITOR, Fixed
-6	CLAMP, Loop
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	WASHER, Flat
	NUT, Hexagon
-7	RESISTOR, Fixed
-8	ELECTRON TUBE
-9	MOUNT, Shield (99789)
	(ATTACHING PARTS)
	EYELET (04264)
-10	BOARD, Printed Circuit
	CIRCUIT BOARD ASSEMBLY No. 4
D-8-	CIRCUIT BOARD ASSEMBLY No. 4 (See figure D-4-7 for next higher assembly.)
-1	RESISTOR, Fixed
-2	RESISTOR, Fixed
-3	RECTIFIER, Silicon
-4	RESISTOR, Fixed
-5	CAPACITOR, Fixed
-6	RESISTOR, Fixed
-7	RECTIFIER, Silicon
-8	CAPACITOR, Fixed (56289)
-9	CLAMP, Loop
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	WASHER, Flat
	NUT, Hexagon

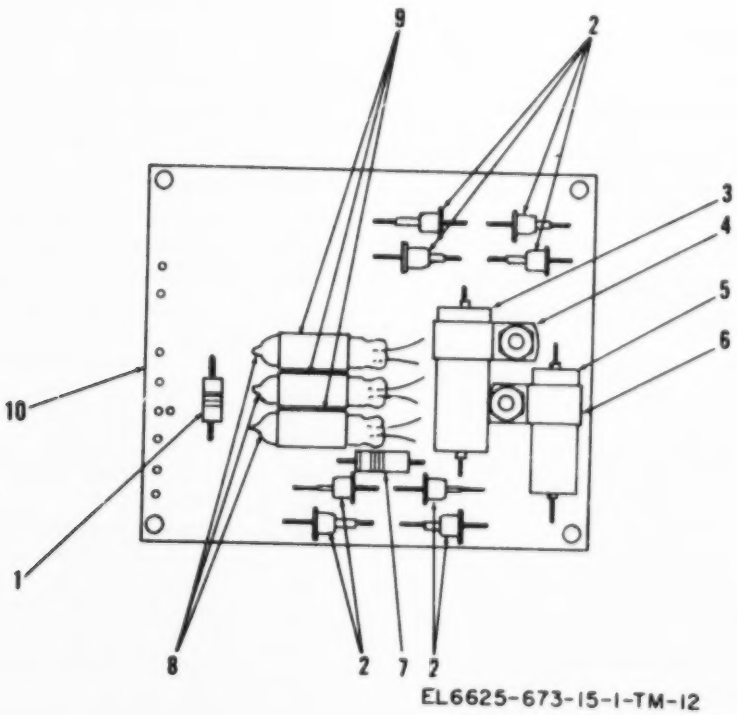

Figure D-7. Circuit board assembly No. 3

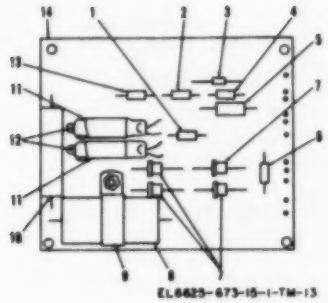

Figure D-8. Circuit board assembly No. 4

Figure and index No.	Description
-10	RESISTOR, Fixed
-11	MOUNT, Shield (99789)
	(ATTACHING PARTS)
	EYELET (04264)
-12	ELECTRON TUBE
-13	RESISTOR, Fixed
-14	BOARD, Printed circuit
	CIRCUIT BOARD ASSEMBLY No. 5
D-9-	CIRCUIT BOARD ASSEMBLY No. 5 (See figure D-4-5 for next higher assembly.)
-1	NETWORK, RC
	(ATTACHING PARTS)
-2	SPACER
-3	BRACKET
	SCREW, Machine
	LOCKWASHER
	NUT, Hexagon
-4	CAPACITOR, Fixed 2.0 UF (99127)
-5	CLAMP, Loop
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	WASHER, Flat
	NUT, hexagon
-6	RESISTOR, Fixed 1 meg ohm (77764)
-7	RESISTOR, Fixed 500K ohm (77764)

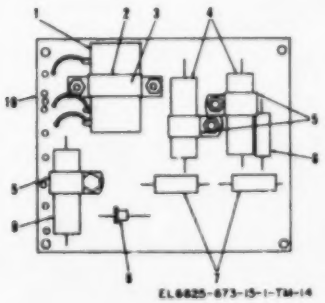

Figure D-9. Circuit board assembly No. 5

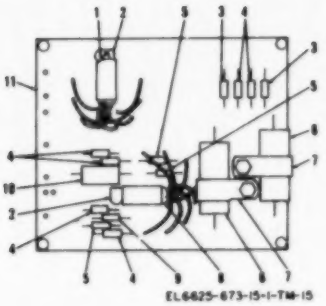

Figure D-10. Circuit board assembly No. 6

Figure and index No.	Description
-8	RECTIFIER, Silicon
-9	CAPACITOR, Fixed
-10	BOARD, Printed circuit
	CIRCUIT BOARD ASSEMBLY No. 6
D-10-	CIRCUIT BOARD ASSEMBLY No. 6 (See figure D-4-3 for next higher assembly.)
-1	ELECTRON TUBE
-2	MOUNT, Shield (99789)
	(ATTACHING PARTS)
	EYELET (04264)
-3	RESISTOR, Fixed
-4	RESISTOR, Fixed
-5	RESISTOR, Fixed
-6	CAPACITOR, Fixed 2 UF (56289)
-7	CLAMP, Loop
	(ATTACHING PARTS)
	SCREW, Machine
	LOCKWASHER
	WASHER, Flat
	NUT, Hexagon
-8	ELECTRON TUBE
-9	RESISTOR, Fixed
-10	CAPACITOR, Fixed
-11	BOARD, Printed Circuit
	DRIVE ASSEMBLY, VARIABLE
D-11-	DRIVE ASSEMBLY, VARIABLE (See figure D-2-32 for next higher assembly.)
-1	MOTOR
	(ATTACHING PARTS)
-2	SCREW, Fil. Hd.
-3	LOCKWASHER, Int. Tooth
-4	CONNECTOR
-5	GENERATOR, Tachometer
	(ATTACHING PARTS)
-6	SCREW, Fil. Hd.
-7	LOCKWASHER, Int. Tooth
-8	GEAR, Generator
	(ATTACHING PARTS)
-9	PIN, Spring
-10	GENERATOR, Tachometer (83555)
	(ATTACHING PARTS)

Figure and index No.	Description
-11	SCREW, Pan Hd.
-12	LOCKWASHER, Int. Tooth
-13	GEAR, Idler
-14	RING, Retaining
-15	BEARING, Ball (38443)
-16	BEARING, Ball (38443)
-17	STUD, Gear (ATTACHING PARTS)
-18	SCREW, Pan Hd., Nylon Insert (03038)
-19	GEAR, Idler (ATTACHING PARTS)
-20	RING, Retaining
-21	BEARING, Ball (38443)
-22	BEARING, Ball (38443)
-23	STUD, Gear (ATTACHING PARTS)
-24	SCREW, Pan Hd., Nylon Insert
-25	BEARING, Ball (38443)
-26	SHAFT, Pinion
-27	BEARING, Ball (38443)
-28	GEAR, Spur (ATTACHING PARTS)
-29	SCREW, Fil. Hd., Nylon Insert
-30	RING, Retaining
-31	SHAFT, Tachometer
-32	BEARING, Ball (38443)
-33	SPACER, Bearing

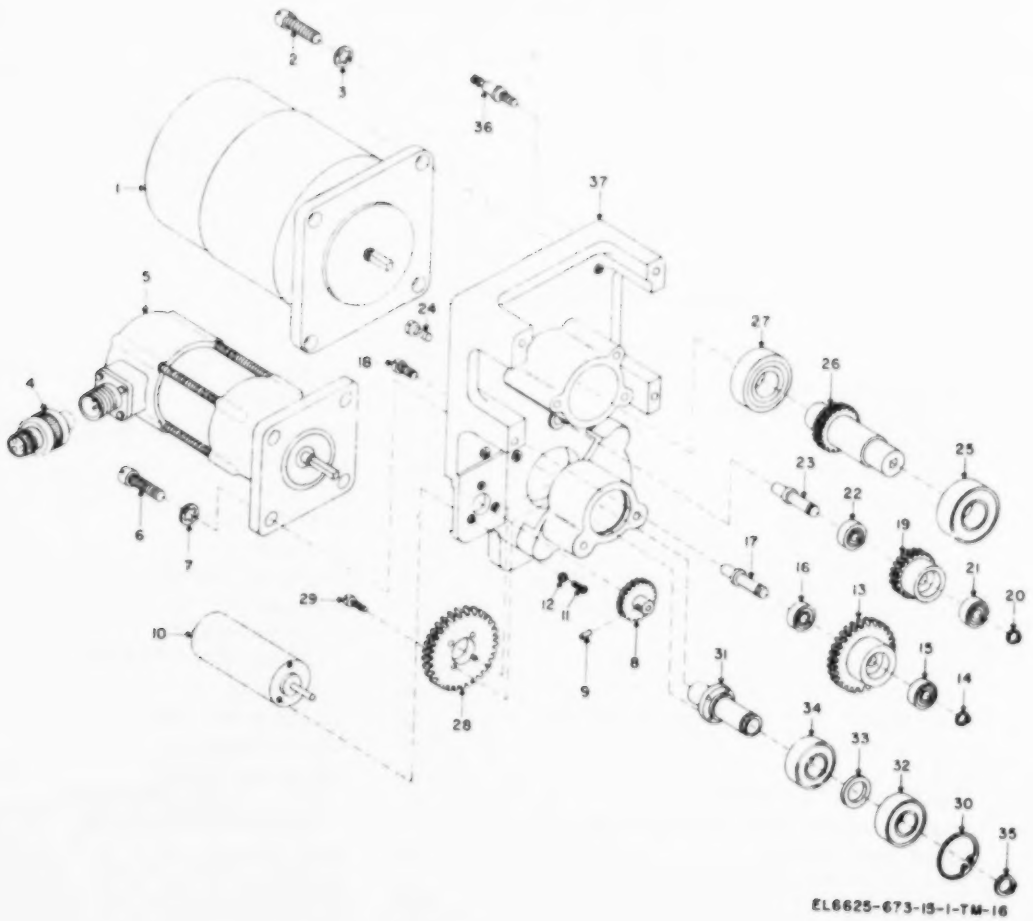

Figure D-2. Variable drive assembly.

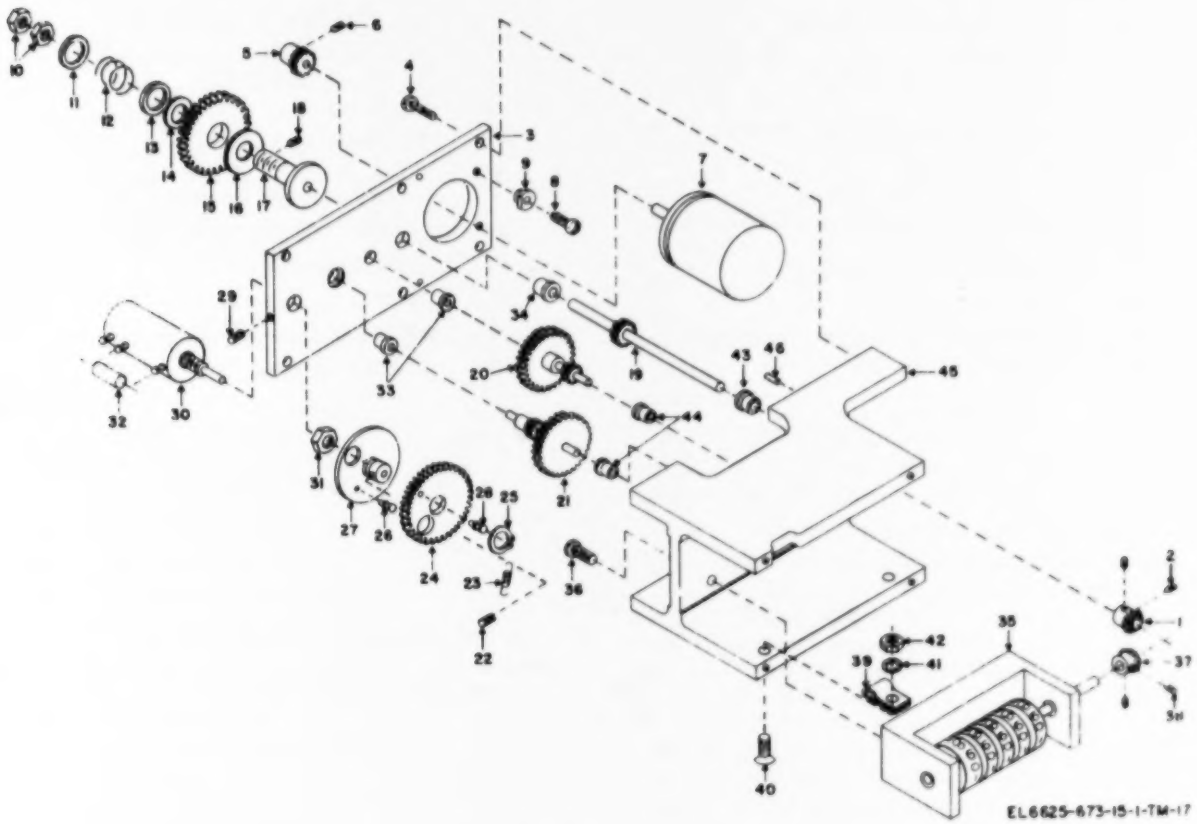

Figure D-12. Digital speed indicator assembly.

Figure and index No.	Description
-34	BEARING, Ball (38442) (ATTACHING PARTS)
-35	RING, Retaining
-36	TERMINAL (71279)
-37	PLATE, Drive Gear
	INDICATOR ASSEMBLY, DIGITAL SPEED
D 12-	INDICATOR ASSEMBLY, DIGITAL SPEED (See figure D-2-35 for next higher assembly.)
-1	GEAR, Miter (71041) (ATTACHING PARTS)
-2	SETSCREW, Hex. Soc. Cup Pt., Stl. No. 6-32 x ⅛ in. lg.
-3	PLATE (ATTACHING PARTS)
-4	SCREW, Fil. Hd., Nylon Insert (03038)
-5	GEAR, Spur (71041) (ATTACHING PARTS)
-6	PIN, Spring
-7	MOTOR (8268) (ATTACHING PARTS)
-8	SCREW, Fil. Hd., Nylon Insert (03038)
-9	CLEAT (00141)
-10	NUT, Plain Hex., Stl. 5/16-32 x 3/32 thick
-11	SPACER (00141)
-12	SPRING
-13	SPACER (00141)
-14	WASHER
-15	GEAR, Spur (00141)
-16	WASHER
-17	CLUTCH SHAFT (ATTACHING PARTS)
-18	PIN, Spring
-19	GEARSHAFT, Spur
-20	GEAR ASSEMBLY
-21	GEAR ASSEMBLY GEAR & BASE ASSEMBLY (ATTACHING PARTS)
-22	PIN, Spring
-23	SPRING
-24	GEAR (ATTACHING PARTS)

Figure and index No.	Description
-25	RING, Retaining
-26	TERMINAL, Turret (04183)
-27	GEAR, Base (ATTACHING PARTS)
-28	TERMINAL, Turret (04183)
-29	SETSCREW
-30	RESISTOR, Variable, 10K ±3%, Linearity ±0.1%, Temp. Coef. ±20 PPM/°C (73138) (ATTACHING PARTS)
-31	NUT, Plain Hex. ⅜-32 (supplied with item 31)
-32	CAPACITOR
-33	BEARING, Bronze (70901)
-34	BEARING, Bronze (71041)
-35	COUNTER (18911) (ATTACHING PARTS)
-36	SCREW, Pan Hd., Nylon Insert (03038)
-37	GEAR, Miter (71041) (ATTACHING PARTS)
-38	SETSCREW, Hex. Soc., Cup Pt., Stl. No. 6-32 x ⅛ in. lg.
-39	CLAMP, Cable (95987) (ATTACHING PARTS)
-40	SCREW, Flat Hd.
-41	LOCKWASHER, Int. Tooth
-42	NUT, Plain Hex.
-43	BEARING, Bronze (71041)
-44	BEARING, Bronze (70901)
-45	CASTING
-46	PIN, Dowel

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W. C. WESTMORELAND,
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Chief of Staff.

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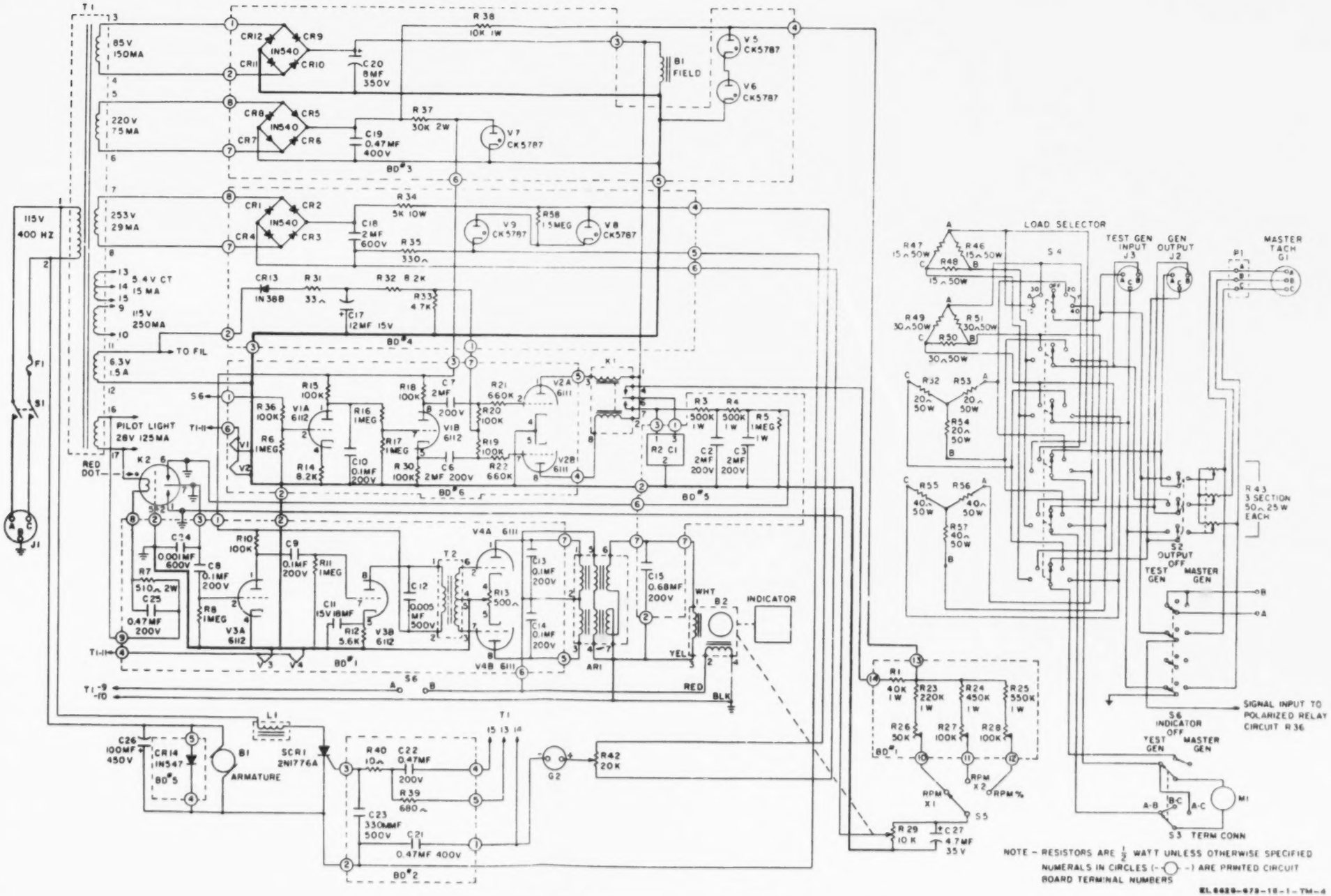

Figure 2-2. Test Set, Indicator-Generator, Tachometer TTU-27/E, schematic diagram.